THROUGH SCIENCE TO FAITH

THROUGH SCIENCE TO FAITH

BY

NEWMAN SMYTH

Knowing that Nature never did betray
The heart that loved her

WORDSWORTH

NEW YORK
CHARLES SCRIBNER'S SONS
1902

Published, February, 1902

UNIVERSITY PRESS · JOHN WILSON
AND SON · CAMBRIDGE, U. S. A.

PREFACE

THIS volume contains a course of lectures which were given before the Lowell Institute in Boston during the winter months of 1900–1901. It was their object to answer the inquiry whether, through the science of the century which was then passing away, the coming age might enter into richer possession of the spiritual faiths which have been man's heritage through all the centuries.

Modern science is a new appeal to nature. Our inherited religious faiths cannot maintain their power, and they ought not to survive, if they fail to accept fully nature's answer to the latest appeal of our science, and if they do not search diligently for the true interpretation of new disclosures of life. The teachers of divinity to the coming age will need, as an essential element of the instruction in schools of theology, a working knowledge of modern methods of scientific inquiry. For the assurance of faith cannot be maintained from a fortified critical position outside the province of the evolutionary science; it may be won by positive participation in the work of the scientific world. Some acquaintance especially with biological studies and results should be made a required part of any thorough education for the modern ministry of the word of life. In this promising direction of inquiry the younger ministry may find from the following chapters some suggestive aid for their further studies.

This book is not intended for teachers only, but more generally for readers who would inform themselves concerning the scope and tendencies of the evolutionary science since Darwin's time, especially in its relation to our most cherished human faiths and hopes. We have had enough, indeed, of too hastily conclusive and often unverified popular articles concerning the religious teachings of modern science; there is need of painstaking and appreciative sifting of the results of modern investigations of nature in order that we may understand their real bearing upon the highest problems of human concern. To many persons who are too busy to search for themselves among the strictly scientific sources of knowledge, but who also are too thoughtful not to be interested in such inquiries, this volume may come as an endeavor to meet this need.

As the lectures, which are here revised for publication, were originally prepared for a general audience, technical expressions and too detailed scientific discussions have been avoided; but for the aid of students who may wish to pursue these inquiries further, and with critical minuteness at various points, numerous references to scientific authorities and contributions have been added in the foot-notes. Many of the articles cited contain full summaries of the literature of the subjects to which they refer.

To scientific investigators, likewise, — the author ventures to hope — it may not seem a useless or unwelcome endeavor, if a guest in their laboratories and an admirer of their patient and ingenious researches, would take the accepted results of their inquiries, and seek to understand and interpret them in their larger relations to the outlying realm of human thought and life. He trusts that this book — the fruitage in his religious thinking of seeds gathered from their fields — may be received in scientific circles as a grateful recognition, from the theological side, of the value of faithful scientific work not only to the material welfare of the world, but also for the higher moral and spiritual life of men.

I would mention my personal indebtedness for aid in the laboratory, and for valuable suggestions, to Professor S. I. Smith, and to Dr. W. R. Coe of the Sheffield Scientific School of Yale University; and readers of this volume will be indebted also with me to Dr. Coe for his very excellent drawings of the diagrams which illustrate the contents of that most wonderful thing in the world, the living cell, and the fascinating mystery of its process of self-division and multiplication.

NEWMAN SMYTH.

New Haven, Conn., Jan. 1, 1902.

CONTENTS

CHAPTER I

PAGE

The New Point of View 1

CHAPTER II

Evolution as Revelation 25

CHAPTER III

The Fact of Direction in Nature 50

CHAPTER IV

Direction in the History of Living Cells 68

CHAPTER V

Intelligent Character of Direction in Nature . . 95

CHAPTER VI

Moral Character of Direction in Nature 116

CHAPTER VII

The Significance of the Beautiful 133

CHAPTER VIII

The Coming of the Individual 160

CHAPTER IX

PAGE
Retrogression in Evolution and Man's Fall 193

CHAPTER X

Restoration in Evolution 205

CHAPTER XI

The Principle of Completion 228

CHAPTER XII

The Prophetic Value of Unfinished Nature . . . 250

INDEX 277

THROUGH SCIENCE TO FAITH

THROUGH SCIENCE TO FAITH

CHAPTER I

THE NEW POINT OF VIEW

Nearly two centuries ago a young man, who had begun to study divinity, wrote to a theologian, "I design the search after truth as the business of my life." Some decades later in the same century another young man who had recently published his thesis as a doctor of medicine wrote to an older man who had become a chief scientific authority of his time, these words concerning the common object of their pursuit: "This is your view, also, glorious man. We are investigating for truth only; we seek that which is true. Why then should I contend with you?"

The first youth who at school proposed to make truth the business of his life, afterwards became known as Bishop Butler, the author of that famous Analogy which far down into our own time has been used as a text-book in our colleges, and which has proved a noble discipline to many minds in search for truth. The other student, Caspar Friedrich Wolff, who had questioned in his thesis the prevalent biology of his day, succeeded in finding truth which has entered into the science of the present age. The common desire to follow after truth only, which was manifested by the theologian and the biologist, is the spirit in which all inquiries into nature and divinity should be made. Their agreement in the pure love of truth near the beginning of the modern era of investigation may be regarded as a happy omen of some future harmony of all science and religion. It is in this spirit that we are to seek again and again to interpret nature. Distrust of nature's fact were unbelief in nature's God. We must follow the course of nature, if we would know how the living One has gone before us in the way.

During the century just ended two epochs in the relation of science and faith, broadly speaking, may be distinguished; and a third and better era is dawning at another century's beginning. The first period was one of religious alarm and scientific conflict. The appearance of Darwin's books on the *Origin of Species* and the *Descent of Man*, was accepted as a challenge to the then prevalent religious view of the creation, and a period of warfare ensued. That was one era, and it was followed by another, which may be described as the time of truce between scientific writers and theologians. There has been of late years a period of compromise between science and religion. Naturalists have learned to avoid needless collision with man's religious faiths, and theologians have become careful so to state their beliefs as to avoid conflict with scientific theories. This has been largely a negative and critical era. But the third epoch is coming — it is already come; it follows naturally after the eras of conflict and of compromise. It is the age of reconstruction. It is to be a positive era, a productive age, requiring for its task no longer the agitator or the obstructionist, the iconoclastic scientist or the controversial divine; but it calls for deeper investigations and for larger interpretations both from its science and its faith.

The older natural theology, in which but a generation ago Christian faiths might still find safe and comfortable shelter, has become uninhabitable; the new is yet to be built. The materials for it are already abundant and rich. Fresh inquiries are inviting; larger vistas are opening; nature is becoming more spiritually fascinating even to the scientific lover of her truth. Particularly during the last half of the past century has science made a vast contribution to our knowledge of living nature. Biology has opened up a marvellous field for exploration which before had been almost an unknown land.

Our science, it is true, must still strike midway into the path of life on the earth. We cannot go back to some distant and lowly point and say, There was the beginning of all. Nor can we say on any visible height of being, This is the end of all. Our knowledge in its utmost extension is of intermediate things. But it is true knowledge so far as it goes. Midway, and for some distance, we have followed with scientific care the course of life far enough to know something of its direction from the distant past and of its possible tendencies beyond our present experience. In this knowledge of life and its history, the larger part of which has been gained during the closing decades of the century, a new point of view has been won. From it all our natural and Christian faiths are to be resurveyed. They are to be observed anew from higher ground and in larger horizons. We have learned from a century's science that we are no longer to think of the world and its Maker under Paley's familiar similitude of a watch and its designer; for we now know that things have not been put together in nature as an artisan would assemble the several parts of a machine; we have now to consider all things around us, and the constellations in the skies, as One of old taught the disciples to consider the lilies, how they grow. For the new science of nature is a study of the method of its growth. It is characterized in general by the word evolution. But that word is far too elastic to serve as a scientifically definitive term. An assortment of diverse views may be bound up by it as by a rubber band. It may cover alike much science and considerable ignorance. It may be employed generally to designate the modern scientific conception of nature; and it may be used precisely to designate a special and now outgrown view of the creation which obtained over a hundred years ago, — the view that all creatures preexisted in miniature in the egg, or were preformed in the germ. No close thinker can define his position now by a word which has been so overworked. We may all call ourselves evolutionists, and speak popularly of the evolution of everything under the sun; the real question would remain, what kind of evolutionists are we?

The new point of view might be characterized still generally as the biological conception. Biology is the science, almost the new science of living matter. It includes comprehensively all investigations of the processes, forces, conditions, and laws, which may be known in the organic world. In its larger scope, and in relation to the outlying problems of life, it passes into a philosophy of the living world. Herbert Spencer's *Principles of Biology*, for instance, constitute a part of his system of philosophy. If we find that our modern biology has discovered any ruling ideas in the organic realm, and if it has followed them far enough through the history of life to be sure of them, we should take such principles of life up into our philosophy, and use them in our effort to become masters of the world in our thought of it. Spiritual mastery of the world, we may be sure, cannot be won except by discovery and use of the actual principles which run through nature.

In this discussion of questions which lead up to the higher interpretation of life we shall start from the naturalist's point of view. It shall be our purpose to seek, especially among recent biological materials, for signs and evidences of the constitutive principles of nature; and through these, so far as they may be revealed, to find some surer and clearer interpretation of our life. Our method will be a simple, but positive method. We shall not seek to adapt science to religion, or to impose faith upon science. We shall seek to learn first from the biologists the significant facts which they have observed. Secondly, we shall accept and make the most of their theories or explanations of the observed facts, so far as they may be made to go. Then, thirdly, we shall inquire for ourselves, what may be their higher and larger significance for our rational and religious conception of the world. We shall thus hope in a positive method, and not merely by a critical marking time, to make a fresh start at least in the way towards a more scientifically spiritual understanding of the creation — of its underlying unity, of its informing principles, of its real continuities through all its spheres, and of its possible completions beyond our present knowledge.

At the outset we would emphasize the vital religious importance of the new inquiries into nature which may now be conducted in this method. If at times such scientific excursions may seem to lead into regions remote from our practical interest in life, they will be found to return ere long with some fresh contribution to our personal creeds for the conduct of life. For our present endeavor will be much more than a temporizing effort, such as the theologians have so often made, to arrange some common terms in which science and faith may dwell amicably together, like boarders in the same house. We shall seek rather to learn and to own their natural relationship. We would bring to mutual recognition principles in which they have a common heritage. If there are such principles, and we may know them, — constitutive and vital principles which run up and down through all nature and life, from the least and lowliest to the heights of being and of destiny— strong, infrustable principles, upon which as on invisible but continuous laws all the spheres are threaded; — then surely these principles are the great powers of nature and of life for us to lay hold of with a firm religious trust. We can build our highest religious faiths safely, if we may build them on the sure foundations of nature.

On the very threshold, however, of such inquiry, we are met by two difficulties which seem at first sight to bar our way in this direction. One of these obstacles lies in the admitted fact that biology is itself an immature science, — almost the youngest of the whole family of the modern sciences. It is hardly twenty-five years since it became a well equipped working science, and it is not yet half-endowed in our Universities. The name compounded for one of its chief branches of investigation, Cytology, or the science of the living cell, is almost an unknown term even to the educated public. Moreover, in the current numbers of the biological magazines, not only do different theories come into frequent collisions, but also the investigators do not always report that they have seen precisely the same things through their microscopes. Many important facts in the behavior of living cells are not well known as yet, and indeed living nature sometimes seems to have an almost feminine power of becoming most fascinatingly elusive just when a man is most eager for some decisive manifestation of her meaning. Many biological views which attract attention must still be regarded as tentative. No one theory of heredity can claim as yet general acceptance. The domain of life is too large and wonderful, and the processes of nature are too subtly involved in the whole spiritual mystery of being to be easily comprehended within some single and simple formula, which some over-confident investigator may propose as the solution of the whole matter.

Nowhere more than in the biological field is there need of that virtue which Dr. Chalmers so happily characterized as the modesty of true science. The present attitude of our ablest investigators in this field of research is one characterized by much reserve and hesitancy of judgment. And when all possible inferences seem to have been drawn from the known facts, the only way of progress is to return to new investigations. These are being made in our biological laboratories by many and most skilful observers. Not long since a fresh student in one of these laboratories brought to his work a blank note-book, the alternate pages of which were neatly labelled "observations," and "philosophical deductions from observations." His professor told him that the division was right, but that he thought he would need far less space for his philosophical deductions. Biology at the present time is mainly engaged in making observations. But observations must in time be arranged under some idea, fertilized, as it were, by some stimulating thought, if they are to be made fruitful; and the philosopher with his ideas and interpretations naturally follows the investigator. It is his task to institute what might be called the higher criticism of science. Interpretative biology may be called the higher biology. The two should not be confounded, — the work of the single-eyed observer, and the task of the rational interpreter; but each serves the other, and the work of both is necessary to a complete scientific and rational conception of nature and life.

The present confessed uncertainty of much biological science may teach us caution, and keep us from venturing our faiths too largely out upon any prevalent theory of life; but, nevertheless, the effort to think biologically, that is, to think under biological forms of conception and in relation to biological principles, is now a possible mode of thought, and it is justified by the knowledge which has been already won. For notwithstanding all uncertainties many important facts of biology are well ascertained, and certain processes of living matter have been followed with definite observations, so that vital principles to some extent may be deduced from our present biological knowledge. By means also of the different theories, with which investigators are seeking to light up the field of life, we may follow more intelligently and confidently the rational ways along which nature from her lowly origins has been led with ever increasing spiritual ascendency up to the heights of man's being, and his life of free thought and love. In short evolution as a general conception of the world and of the methods of life, within the past fifty years of scientific observation, has advanced fully far enough to require now and to justify the construction of a new natural theology; and that in its turn will lead to some reconstruction of Christian theology.

We offer therefore no further justification for our task than this, that it is now possible to attempt it, and that its achievement is greatly to be desired.

The other difficulty which has been raised, is independent of the extent, greater or less, of our scientific knowledge; it is an objection which would be always fatal to this endeavor, if at any time it were true. It is said that there is an impassable gulf fixed between the natural and the spiritual spheres, and that we cannot reason from the one to the other. Fanciful analogies, or illuminative imaginations, it is admitted, may be drawn from the natural for the help of man's spiritual thought; but it is asked, can any true analogy, or real continuity of principles, be followed from the lower spheres straight through the ascending orders of nature up to the very highest and into the spiritual world? Curiously enough this question has been raised, and this obstacle is put in our way, both in the name of science and of religion. Coming from opposite directions and proceeding to different conclusions, some scientific students and some spiritual philosophers meet for the moment at this common point, and unite in warning off any attempt to reason either up or down from the natural to the spiritual. Leave to us, say the former, our science, and we will leave to you, as beyond our ken, your faith. Attempt to connect the two, and you will only succeed in confusing science, and introducing doubt into the domain of faith. And some of the latter, the philosophers and theologians, likewise, will go on their separate way, quite content to affirm that man stands wholly apart in the creation, and that his supreme individuality is not to be understood as nature's grand climax. Thus in this particular these two find themselves for the moment in agreement, — the naturalist who holds his science wholly apart from his faith, and the theologian who holds his faith regardless of any science. Both fail to discern the underlying unity of the creation.

The question thus brought before us is this: Is the created universe one order, and has it come to pass in one process of development? Or does it consist of separate realms, such as the inorganic and the organic, matter and mind, the natural and the spiritual, which are not bound together in any process of development? Are we to regard the creation as a process still going on, like an unfinished drama, or are the worlds and all things therein to be looked upon as a collection of ready-made products of all kinds and sizes, like a vast department store? If we take the answer from science and say, Nature is not a patchwork, its parts and colors artificially matched and fitted into some semblance of design; nature is a continuous weaving of subtle but unbroken threads; if, in a word, we say evolution; then the further question immediately arises, In what does its unity consist? What Haeckel in the title of his last book calls the *Riddle of the Universe*, is not the simple riddle of one soulless substance which he thinks it is in his drear denial of all divinity; the problem, the ultimate mechanical and spiritual problem of the universe, is a double problem, partly scientific, and partly philosophic, partly a question of fact, and partly a question of interpretation: Is the world one, and, How is it one?

In this introductory chapter we take as the point of departure for the subsequent inquiry the scientific belief that nature is one. Evidences of this fundamental postulate will appear as we shall proceed. The answer to the question, How is it one? is the interpretation of the world which in the course of our inquiries we are to seek from the nature-process itself. As our immediate object is to make clear the starting-point, we may sketch here, more with an etcher's lines than with a detailed description, the new view of nature as one process of development.

From the scientific side the presumption has become immense that there have been no real breaks in the evolution of the heavens and the earth. Apparent gaps there may be, which no knowledge of ours can fill up; but there is no fissure anywhere that runs clear through to the foundation of the world. Because we cannot see the bottom of a chasm, however we may peer into its depths, it does not follow that it is a bottomless abyss. We may not repeat in any scientific account of things the story so often told in local traditions of the lake which has no bottom. That simply means that no man as yet may have brought a long enough line to find it. Nature, our science now knows enough to affirm, undergirds the worlds with her strong continuities. This first article of scientific faith in the unity of things relates specifically to their genetic oneness, — their unity, that is, of descent. The creation is genetically one — one in its birth and growth.

We may appreciate the conclusive force of this belief in the unity of the world around us, if we review the discoveries of the relationships between things which have been made during the course of the past century's science.

One of the first of these disclosures of the unity of the world is known as the law of the conservation of energy. It is not poetry only which bids us regard all things as "blossomings of one tree"; it is sober scientific physics which teaches us to find a constant sum of energy through all its ceaseless transformations. There is one energy commutable into the different forms of energy of the physical world, and the same always in its quantity (within any closed system). In other words, nature tickets no form of energy as not transferable, and good for this passage only; and in nature's continuous working no energy seems wasted or lost. This discovery of the unity of energy is the most fruitful conception which has been introduced into physical science. The first comprehensive statement of the law of conservation of energy was published by Mohr in 1837; but our knowledge of it is due not to the brilliant discovery of any one thinker, but rather to the accumulated science of all this modern time.

Another signal discovery of unity has been made in the organic kingdom. In the year 1838 a botanist, Schleiden, showed that all plants are built up of certain simple structural units which he called cells, and he discovered that the origin of the plant life is from a single cell; the succeeding year a physiologist, Schwann, found that the same observations were true of animals; animal tissues likewise are built up of cells, and every animal life proceeds from an egg-cell. This was a most interesting discovery of the fundamental unity of all living nature. The original bricks, so to speak, used in building the vegetable and animal kingdoms, are similar, and the method of laying them is much the same. It is now demonstrated that there is no radical difference, no fundamental distinction in kind, between the vegetable and the animal kingdoms.

If you examine under a microscope a drop of water from a pool which is slightly colored with a diffused green, you will find within it as the cause of its greenish tinge numbers of a small organism, called *Euglena*, which move rapidly about, often changing their form as they move; which have spots of chlorophyll — the coloring matter of leaves — within their minute bodies, and which also may be seen under a high power of the microscope to have a mouth. They feed both as plants and animals feed, partly by means of their chlorophyll, and partly through their mouths, partly from inorganic matter, and partly from other living matter, feeding as plants by daytime in the sunshine, and as cannibals in the night. So this *Euglena* has been claimed by different naturalists as belonging both to the animal and the vegetable kingdom. It is hard to say whether the botanists or the zoölogists may best claim it. Indeed our most skilled naturalists differ in their classification of several lowly organisms which present "a puzzling combination of animal and vegetable characters." "The important point," says Professor Parker, "for the student to recognize is that these boundaries *are* artificial, and that there are no scientific frontiers in nature."[1] The conclusion which our eminent American botanist, Professor Asa Gray, reached years ago, has been confirmed by subsequent researches: "The fact is, that a new article has recently been added to the scientific creed, — the essential oneness of the two kingdoms of organic nature."[2]

[1] *Elementary Biology*, p. 182.

[2] *Natural Science and Religion*, p. 12.

More recent researches have brought out even more curious similarities between plant and animal life than those resemblances in their methods of nutrition and in some points of their conduct which led to the establishment of this new article of the scientific creed. Moreover, botanists are now saying that "the movements by which the parts of fixed plants assume and maintain through life their position, are due to the co-operation of organs of sensation and organs of motion." We are assured that there is "a sense of gravitation" in plants; that the apex of a plant which turns towards the earth (geotropic), is "a percipient organ"; that "a brain function" may be ascribed to the sensitive apex of the root; and one observer claims to have traced "a continuous fibrillar structure" in the substance of the cells (cytoplasm), by means of which stimuli may be transmitted in the motions of plants.[1]

Man also is included in the unity of this structural plan. The Hebrew psalmist said of old in his childlike wonder: "Thine eyes did see mine unperfect substance, and in thy book were all my members written, which day by day were fashioned, when as yet there was none of them." With no less wonder, the reverent eyes of science, through the partial lifting of the veil from the holy mystery of life's origins, may now see how that unperfect substance has been organized, and these members fashioned, even as lowliest plant has grown, and humblest creature has been formed from the proto-

[1] See *Nature*, August 15, 1901, p. 372: *Journal Royal Mic. Soc.*, Aug. 1901, p. 437. Also Dr. Francis Darwin's remarks at the meeting of the British Association, 1901. B. Němec, *Die Reizleitung und die reizleitenden Strukturen bei den Pflanzen.*

plasmic germ, and by the multiplying cell: we too are physiologically one, structurally and vitally one, with all living nature. When Saint Francis in his spiritual ecstasy went through the forests and the fields of sunny Italy calling the animals his brothers, and the birds his little sisters, he was far nearer than he knew to the sober truth of the great biological generalization of modern science that all living nature is of one descent and constitutes one relationship.

When all this, however, has been admitted, the question will be raised: Are there not still left some wide gaps in nature across which science cannot throw any material bridge? What shall be said of the difference between life on the one side, and the inorganic world on the other? Has that fixed gulf been bridged by any chemist? Can we analyze the vital phenomena of irritability, or of reproduction, or of adaptation entirely into physical and chemical processes? Candid biologists generally admit the present impossibility of such analysis. So the American authority, Professor Wilson, in agreement with similar utterances by a leading German embryologist, Professor Hertwig, leaves the matter at the conclusion of his exhaustive treatise on the *Cell;* "The study of the cell has on the whole seemed to widen rather than to narrow the enormous gap that separates even the lowest forms of life from the inorganic world."[1] But, nevertheless, modern biology teaches with general consent that there is an unbroken development from non-living to living nature, although the lines of connection between the two may lie beneath our sight. In weaving

[1] *The Cell,* p. 434.

the garment of life nature has spun her threads very fine, and sometimes they may be too subtle for our clumsy fingers to unravel them ; but nevertheless nature, passing from the non-living to the living, has nowhere broken her thread, and the richly variegated pattern of life has been woven firmly into the woof of her inorganic strength. Biological science includes and affirms in its first article of genetic descent a belief in some natural relationship between the inorganic and the organic worlds.

It will be admitted that life now does not proceed directly from inanimate dust; that living creatures are not, as even some scholastic theologians once supposed, generated spontaneously from dead matter under existing conditions. Biology now goes still further and asserts not only that every life comes from some preceding life, but also and more minutely, that every living cell proceeds from some pre-existing living cell, and that the germ-plasm — that is, the germinal matter of life — is continuous and possessed of an earthly immortality. But while the fact is universally admitted that non-living matter cannot now be organized into a living form except through the prior agency of life, on the other hand the momentum of all our scientific knowledge of the continuities of nature leads modern biology to the assumption that the organic substance at some time has been raised and quickened from the deadness of the inorganic world. When the right conditions were offered, when the fulness of the time for its advent was come, naturally, and without violence, as without observation, in the midst of the inorganic world the kingdom of life came.[1] The same energy which had slowly fashioned and combined the molecules for life, at the appointed hour lifted them up into life. Such scientific faith in the evolution of the organic through the inorganic may imply, as we shall have occasion to argue later, the existence of some unknown or mathematically immeasurable factor in evolution. But we refer in this connection to the scientific belief that nature makes no break in becoming living nature, as a further sign of some real and fundamental unity of the world. At this point, likewise, before this striking difference between life and inanimate things, the question — the only question which science leaves open — is not, Are these two one? but, In what does their unity consist? As between the crystal and the living cell the problem is not, Are they related, but, What is the source and ground of their relationship? This last question we shall discuss further on when we consider the higher interpretation of life.

One characteristic of living matter, which will come before us later more fully among the signs of the spiritual significance of life, should be noted at this point, for it indicates the unity of evolution which science impels us to assume, while it compels us to seek for that unity deeper down than in any visible lines of its physical and chemical continuity. We refer to that characteristic of it which has been happily hit by Professor Shaler's phrase that living matter is educable matter;[2]

[1] See Verworn, *General Physiology*, pp. 297 *sq.*, for theories of the origin of life.

[2] *The Individual*, pp. 23 *sq.*

that is, it is matter which has become capable of receiving an education. It has acquired the power of continuously adapting itself to its changing conditions, and of improving itself. Protoplasm has learned to make "an adaptive response."[1] On the one hand, so close is the natural kinship between living and non-living matter that it is not easy to draw any hard and fast chemical or physical line of separation between the two; the differences usually advanced are found on more intimate acquaintance not to hold. Living matter is still matter. But, on the other hand, this striking peculiarity, this newly acquired power and promise distinguishes life from the beginning; it is matter which has acquired capacity for self-adaptation and self-improvement; it has capacity for education. Non-living matter cannot be trained through experience; living matter can be; it is matter selected and put into a course of training; it will profit by experience. A crystal will always crystallize in the same geometric forms; an organism will change its form to make better use of its environment. Furthermore living organisms can give to successive generations their accumulating gains. But mineral salts through the ages will remain always the same mineral salts. A diamond cannot divide itself into two more valuable and brighter diamonds. Life can. Living matter is capable of continued self-improvement. Animal life gains habit, and transmits tradition. It acquires in time clear adaptive intelligence. In brief, it is this capacity for intelligence, this receptivity and growth for the action

[1] Wilson, *The Cell*, p. 433.

and free play of adaptive intelligence, which above everything else distinguishes living matter. It has marked it from the beginning. And it crowns it at the end.

How did organic matter in the course of nature ever acquire this educable quality? That is a fundamental biological question. It is more; whatever may have been the method of the acquisition of this vital capacity, the fact that it has been acquired, compels an evolutionist to seek for some conception of the unity of nature deep enough and large enough to comprehend both the dead and the living. Otherwise the scientific evidence of the unbroken ascent of the organic from the inorganic world would be a confusion of thought. If we are to hold to evolution as the method of nature, our idea of evolution must be comprehensive enough to include all the facts, and to sum up in one their differences.

There are two other apparent breaks in nature which theologians have been in the habit of regarding as unbridged chasms in evolution, as though the supposed existence of such breaks were an aid to religious faith, and room must be left through gaps in nature for the living God to come in. How slow of faith we have been to learn that the Divine Spirit does not need to work through gaps. We may need to discover that the order of the universe may be the very mechanism for the divine Will. The fine continuities of nature shall prove to be the facile and magnetic lines for the energy of the Spirit.

One of these supposed breaks, which the science of the century has found to be a closed circuit, is the evolution of animal intelligence. There has been one progressive growth of intelligence in connection with the development of living matter.

At the bottom of the scale of animal sentiency, hardly a perceptible degree above the zero-point of intelligent life, we see the apparently aimless motions of an *amœba*, as that primitive speck of protoplasm may be watched under the microscope, throwing out now in this direction, now in that, arm-like projections of its almost structureless lump of living jelly, and another moment rolling its whole little self into a round ball. Near the top of the organic ascent, just below the critical point on the scale where intelligence becomes distinctly human, we perceive the adaptive motions of the higher animals — the graceful bounds of a deer through the forest away from the hunter's aim, or the balancings of the eagle in its repose of airy flight, or the almost human responsiveness of the dog; — and between these two, from the lowest organic sentiency to the highest animal intelligence, the way seems long and the distance immeasurable. These two, we might suppose, — the irritability of an *amœba* and the instinct of a bird in the sky, — nature never could have bound together by law of continuous growth; but we know as a clear result of scientific searching that nature has bound them together. It is one history of the coming of intelligence in the animal kingdom. We may accept, as scientifically put, Mr. Lloyd Morgan's inference from his studies of instinct, that "consciousness arises out of something associated with the material egg, which, though not yet consciousness, develops into consciousness."[1]

[1] *Habit and Instinct*, p. 127.

Granting, however, that up to this point nature may have been one process, some thinkers, in the supposed interest of their souls, have taken a final stand upon Man's superior nature, and before the supreme fact of his intelligence they have said to an evolutionary science, "Hitherto shalt thou come, but no further; and here shall thy proud waves be stayed." But here likewise the answer from science will be: Yes; Man's reason is the supernal Fact; but in fulfilment of one law, out of the deeps of nature's vast mystery, there has been formed and exalted even that sublime verity of reason, which now has upon its summit the Spirit's transcendent light.

If then we start, from the naturalist's point of view, we cannot set aside the tremendous scientific presumption that all nature, including life, animal sentiency, and man's intelligence, is one realm, one process, one book; and as such it is to be studied and re-read now by true searchers for its truth. The interpretations of it for which the new natural theology must seek, will be found only by knocking first at the door of fact. Through the way often straight, and the gate often narrow of nature's fact, modern thought must enter, if at all, into its spiritual kingdom.

We begin, therefore, by accepting clearly and positively the great generalization of the nineteenth century's science; viz., the genetic unity and the unbroken development of the whole realm of nature, to which we also belong. We shall seek to follow out several of the chief lines of its evolution, and to interpret their significance. We may thus learn anew, when we shall reach the conclusion, that in sober truth all nature is holy ground, and every "bush afire with God." We may gain a deeper insight into all life and history, if we shall discover that from the beginning natural evolution has been more spiritually minded than we had thought.

We may describe further our point of view, if we compare it with that taken by Mr. Drummond in his famous book on *Natural Law in the Spiritual World.* Mr. Drummond's critics have been quick to perceive the mistake into which his logic fell; they have been slow of heart to perceive the truth which he saw. His error lay on the surface of his book in his assertion that the laws of the natural and the spiritual realms are identical. That is not true even of laws which obtain within different parts of the natural world. The laws of chemistry and of physics, for example, describe the modes of action of energy under different conditions, and a law or description of the one process will not answer for the other. But the truth beneath Mr. Drummond's error may be brought out by a simple illustration. We may say that a poem and also a yacht are beautiful. In what lies the resemblance? Not in the laws of their construction. The poet in his verses, and the architect in his drawings, do not follow the same laws of construction. The lines of the ship are to be wrought in oak and iron according to their laws; and the thoughts of the poet are to be expressed in airy words according to their harmonies. Yet each, the poet and the architect, produces a thing of beauty, and all beauty is one. It is the same delight which we have in it, under whatever form it may come to us. And beneath all the varying forms of the beautiful we may find similar principles of the beautiful. With differences of laws according to the diversities in the materials used, the same ideas of loveliness, the same principle of the beautiful may take form, and find expression. It was an unnecessary mistake for Mr. Drummond to put at the foundation of all analogies an identity of laws. We need not do that to find one reason pervading the whole universe. But Mr. Drummond was right, he was profoundly right in his insight. The truth which he saw, which throughout his whole scientific and religious work he sought to lead others to see, was the reality of the underlying spiritual unity of the world. In speaking of the origin of his book Mr. Drummond once said: "I am well aware that many see no such thread binding Nature and Grace. Others not only see no thread, but see no use in one. I can only say that for me there is no alternative but to see it. . . . Now a thing that we cannot help seeing must either be really there, or one's vision must have some constitutional defect."[1] Mr. Drummond had a sane mind, and there was no constitutional defect in his spiritually scientific vision. It is this truth, not of identical laws, but of certain grand unifying principles which run up and down throughout nature, and which make of all nature one glorious revelation,—it is this supreme truth toward which we now turn and look.

[1] *Life*, p. 160.

CHAPTER II

EVOLUTION AS REVELATION

One of the first impressions which remains among almost the earliest recollections of our childhood, is the sense of wonder. The wonder of the world around us has not grown less with the years which have brought increasing knowledge. We looked as little children up into the blue sky, and at the great white clouds sailing across it, and wondered what it all was. With a wonder now into which are wrought our human joys and sorrows, we ask still, what does it all mean? Modern science has swept the world clear of superstitions, and driven needless fears from the hearth of religion; but it has brought the infinite mystery of things still more closely home to our human hearts. The real question for us at the height of the century's science is not, Is the universe a mystery? but, Is it a mystery of darkness, or of light? The mediæval poet Dante, whom love had led through the spheres to the gates of paradise, stood at last gazing into an infinite radiance, as though "Suddenly upon the day appeared a day new risen." If our science likewise may be led by some love of higher, ideal truth, it will make progress through the spheres of knowledge until it shall gain something like Dante's vision in the empyrean of the flood of light "replete with joy," "where God immediate rules." The infinite universe may remain to finite mind a mystery; but it shall cease to seem as a loneliness of great darkness, and become as a mystery of the dawn, even as a day new risen on the day, while from its vistas of light beyond light come sweet and happy voices.

As we would gain some word of life from nature's prophetic mystery, we must first take heed how we are to hear it. If beneath these changing phenomena there is a Reality which we were made to know, how is it making itself known to us? In other words, our first inquiry is one concerning revelation and its natural method. It is an inquiry of prime speculative importance, and also of supreme practical moment to us, — What is the natural way of revelation? In what manner, and by what signs, if at all, has the ultimate Reality revealed itself from out this mystery of the universe around us? How may it be revealing itself to us even now, if we have eyes to see it?

According to the method of study which has already been sketched, we are to seek for the answer to this inquiry first in the facts of nature. We are to discover the method of revelation in the nature-process itself. Evolution, we are taught, is the method of creation; it is also the method of revelation. Evolution — the whole age-long course of it — has been a revelation. More significantly is this true of nature after it has been quickened into life: the evolution of living nature has been and is a revelation of the mystery which was hidden before the foundation of the world. It is awe-inspiring to follow this revelation of the glory of the dispensation of life from its beginning until now. One can read with reverent wonder the earliest prophetic records of this natural revelation, as the course of it may be followed in the development of cell-life. Indeed when a biologist puts upon a slide for his microscope thin sections which show the successive stages of the development of a cell, he has put upon that bit of glass the primal wonder of the whole living world. The germs and determinants, the predestination and the order, the potentialities and the promise of a whole living universe lie there for him — last development himself of them all — to peer into, and to think over, and to find out concerning them what he may. We envy not the mind of that investigator who, however familiar he may be with these processes of life, can look at them through his microscope without ever reverent thought.

We begin with a description of this earliest revelation of life which is to be observed in the division and multiplication of the cell. We shall begin thus with the primal and simplest facts of natural revelation. To lay hold of the highest religious truths, we do well always to grasp them by their nearest ends.[1]

As we shall have repeated occasion to refer to the cell and its contents, it may be well at the outset to give a general account of it, and of what has been found within it. Eggs are now receiving a vast amount of scientific attention. Good eggs and bad eggs, healthy

[1] See the author's *Personal Creeds*.

eggs and sick eggs, eggs growing normally, and eggs even artificially fertilized, some left to themselves to develop, and others twisted and shaken with laborious ingenuity, are become subjects now of close scientific scrutiny. Hundreds of keen eyes in many laboratories are peering into the secrets which still lie waiting to be found out in the living cell. Its fruitful study is indeed one of the last products of the past century's science. As long ago as the year 1600 the compound microscope was invented; but the use made of it by its earlier possessors has been fitly characterized as a play of science rather than as productive work. Not until the earlier years of the last century was some constructive idea gained of the unity and order of this new, curious microscopic world. Not until the last twenty-five years has cytology, the science of the cell, found a leading place among the sciences.

The name cell is somewhat misleading. It naturally suggests a more or less spherical little body surrounded by a wall of some kind. But the cell, as biology knows it, does not always or necessarily have any outer covering or enveloping membrane; it may consist of a mere naked mass of protoplasm. A white blood corpuscle within your veins is a cell; an amœba, lowest of organisms, is a cell; but although this dot of living matter may be without covering or wall, it will manage to keep itself together, very much as a drop of oil may do in water. Living cells vary also very much in size; they are almost infinitesimal; but they may become as large, for instance, as a hen's egg, which is a simple cell increased by a comparatively enormous amount of yolk spherules as well as by layers of albumen.

When once the great generalization had been demonstrated that all plants and animals are composed of cells, and consequently that we must look ultimately to the cells of which they are formed to understand their nature and life-history; it was not long before more was discovered concerning these elementary corpuscles, which thus had acquired so great physiological importance. At first they were mistaken for very simple affairs, and their contents were quite neglected. But improved microscopes and better methods of research soon brought to light signs of intricate structure within these fine dots of living matter, and their behavior under close scientific scrutiny was found to be by no means so simple and artless as had been supposed. The cell-substance — the living matter — was then demonstrated to be similar in all cells, and was named protoplasm. A cell is a small lump of protoplasm.

But what is that? The biologists are agreed that even this primitive protoplasm shows signs of structure, and already possesses some organization; but they are still far from agreement as to the nature of its ultimate structure. Some regard it as foam-like in its appearance, and others as matter finely reticulated, like the meshes of a net. Or it is supposed to be put together like a bundle of fibres. Another view is that it is composed of innumerable minute granules. The latest researches seem to indicate that it is composed of simpler and finer units which are ultra-microscopical, and which may bear very much the same relation to living matter that the molecules do to other matter. These ultimate units of protoplasm may assume varying arrangements or successive structural forms. Our microscopes certainly leave us still very far from the bottom of this secret. But observers are generally agreed that this apparently simple microscopic cell contains within itself different elements and distinctive parts, which have a definite work to perform in its life-history. One of the larger of these parts, which is easily distinguishable, is the nucleus. It is a well defined dot of matter within the cell, which will take a different chemical stain from the surrounding cell-contents or cytoplasm. This nuclear dot within a dot of living matter proves to be a new wonder; it seems to be the most wonderful thing in the world. For the mystery of the whole subsequent development and organization of a plant or animal, all the differences between the several species of plants and animals, and, besides these, the factors of heredity, and the peculiarities of individuals, seem to lie hidden and packed among the infinitesimal potencies of this minute nucleus of an egg-cell. There it is under the microscope, — the whole mystery of being concentrated at a single point. The problem of the old schoolmen, how many angels can dance on the point of a needle? seems to be surpassed by the cool verity of this scientific calculation, — how can so many specific differences proceed from microscopic matter finer than a needle's point? But they do.

Some of the principal parts of the nucleus will be mentioned as we now describe the revelation of the development of the organism from the egg-cell. This process has been much studied in the egg of a small

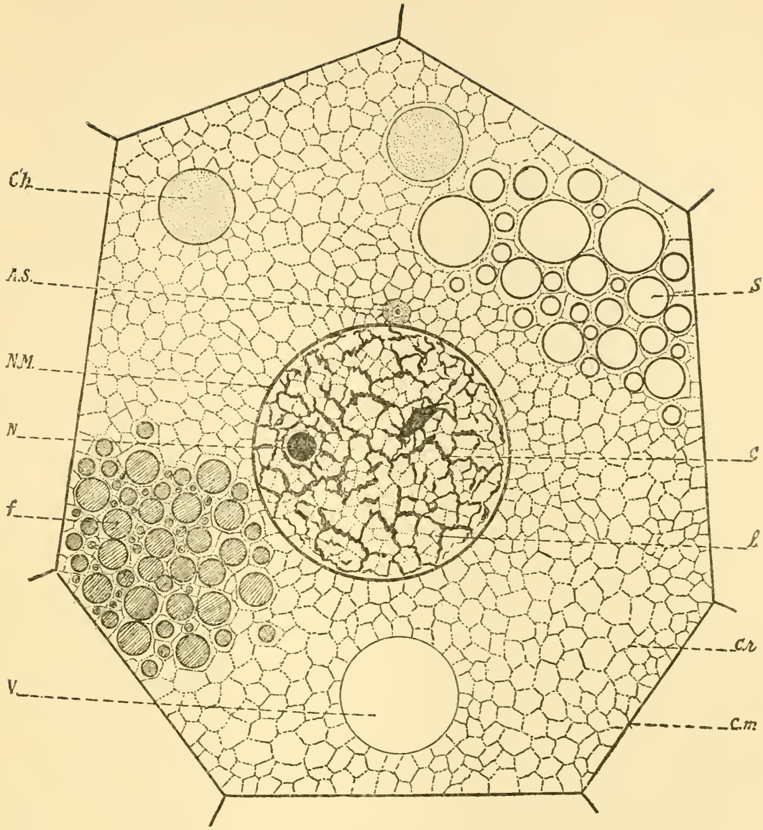


FIGURE 1.

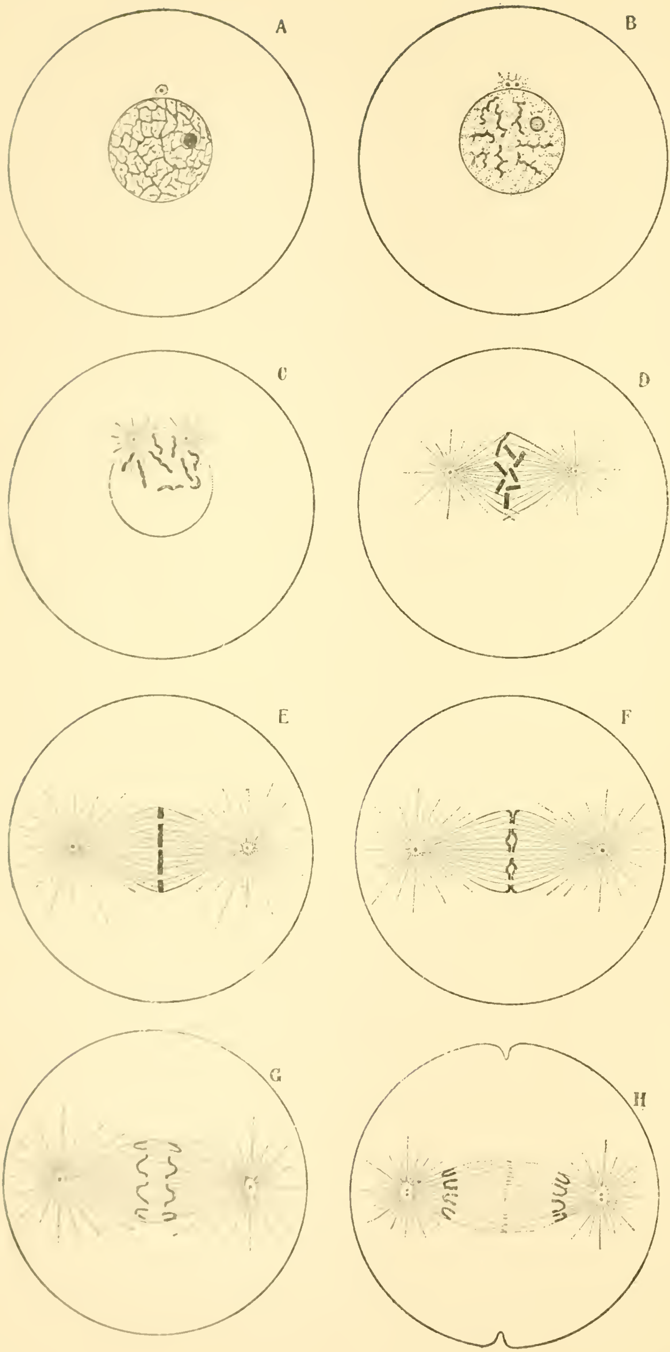
Diagram of a cell. The cell-body is surrounded by a *cell-membrane* (*c.m*), and appears to be permeated by a mesh-work of delicate threads (*cytoplasmic reticulum, c.r*). These threads are made up of minute granules, or *microsomes*, and together with the matrix enclosed in the mesh-work consist of living protoplasm. Other portions of the living protoplasm are differentiated into the various cell-organs, such as the *nucleus*, *centrosomes* and *asters*, and *chromatophores* (*Ch*, found in the cells of green plants).

The nucleus is surrounded by a *nuclear membrane* (*N.M*), and consists mainly of an irregular network of *chromatin* (*c*) suspended in a more fluid matrix by means of delicate threads of *linin* (*l*). The nucleus also commonly contains one or more rounded *nucleoli* (*N*), the function of which is unknown. A small *attraction-sphere* (*A.S*), containing a minute *centrosome*, is found in many cells, and its presence may be looked upon as well-nigh universal among animals.

In the reticulum of the cytoplasm are suspended various non-living bodies, such as food particles (*f*) stored up for the future use of the cell, or secretions, excretions, etc. (*S*), and sometimes vacuoles of cell-sap (*V*).

worm, the *Ascaris.* Our hymn-makers would hardly have taught us to sing, "What worthless worms are we," had they been familiar with the great service which, as Mr. Darwin has shown, the worms render in working up the soil for vegetation; and when we know also the beautiful marvel of structure and growth which biology has discovered even in the egg of the humblest worm, it might be more scientifically true, as well as humble, for us to sing, "What wonderful worms are we!" Certainly our rarest human handiwork is clumsiness in comparison with the intricate machinery and the exquisite fineness of the weaving of the threads of life in the division and growth of the living cell even of the worm.

In order that this working of nature in the development of a cell may be rendered more visible, the microscopists first cut them into series of thin sections which are then stained with chemicals by means of which differences in their structure are rendered apparent. When we examine under a high power of the microscope a series of sections of a fertilized egg, the veil begins to be lifted from the holy place of life's reproduction. But the Power which dwells within this temple is unseen. First the nucleus of the ovum, the egg-cell, is matured and prepared for the beginning of a life-history by a succession of interesting changes which for the moment we will not seek to describe; then a germ from without, which also has been prepared for its work, enters it; and behold! a new process of life has been microscopically begun, which shall not fail or falter, which shall go from strength to strength and grace to grace until in the adult form its primal mystery of being shall have been revealed. One of the first signs to be marked in the development of the cell, is the appearance of two points called centrosomes, from which emanate star-like rays. These asters, as they are designated, at first lie near each other, but they will soon draw apart until they are seen lying at opposite poles of the cell. Meanwhile there is woven between them, no one can tell how, a number of fine threads, which expand in the middle of the cell, and which are gathered together at each pole, — the whole structure thus formed resembling a spindle. Near the middle part of this spindle are to be seen a number of lines or loops of matter, which may be clearly distinguished because, on account of some peculiar chemical constitution, they take a deeper stain than the rest of the egg-substance. And still the revelation of the mystery of life grows before our eyes; for these loops, which are called chromosomes, will next split lengthwise into equal halves, — no one really knows how: — and then these halves are gradually drawn apart, and — by what attraction we can only imperfectly understand — one half of them gather around one of the aster poles of the egg, while the other half are drawn to the opposite polar star. By this means nature secures in the earliest embryonic organization an equal division of the matter within the cell which bears the hereditary properties. These equally divided loops are now known to be composed in equal proportions of maternal and paternal elements of the organism. Then, when these carefully halved chromosomes have been thus impar-


A
B
C
D
E
F
G
H

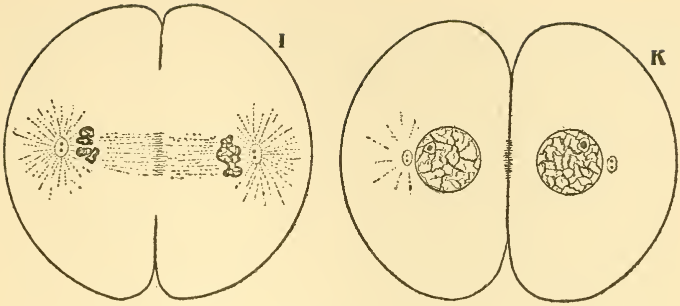


FIGURE 2.

Diagrams illustrating the process of cell-division, or *mitosis*.

A. Cell in the so-called "resting" stage; that is, not undergoing division. Above the nucleus is a centrosome. The nucleus shows the irregular network of *chromatin* and a rounded *nucleolus*.

B. Cell preparing for division: the centrosome has divided into two daughter centrosomes, about which the *amphiaster* is beginning to form. The chromatin-network has resolved itself into a definite number of *chromosomes*. The nucleolus is beginning to degenerate.

C. The asters have increased in size and the chromosomes are being drawn towards them. The nuclear membrane has partially disappeared.

D. The asters have become much larger, a *spindle* is formed between them, and the chromosomes are being drawn to the equator of the spindle.

E. The amphiaster has reached its maximum in size and perfection. The chromosomes have become arranged symmetrically exactly in the equator of the spindle. In this and the following figures but half of the supposed number (eight) of chromosomes are shown.

F. Each chromosome is splitting longitudinally into identically equivalent portions, the *daughter chromosomes*, which in *G* are being drawn towards their respective asters.

H. The daughter-chromosomes are approaching the asters, the centrosomes of which have already divided in anticipation of the next cell division. On the equator of the cell appears a slight constriction of the cell-membrane, which gradually deepens as the cell-division proceeds.

I. The daughter-chromosomes having reached their respective asters, swell out into vesicles which fuse together to form the daughter-nuclei. The asters are degenerating.

K. Division into two cells completed. The asters have practically disappeared, and the centrosomes will be lost to view a little later. The constriction seen in Fig. *H* has deepened until the cell-body has been cut in two at its equator. The daughter-nuclei have increased in size by the absorption of food from the cytoplasm, and a nucleolus has appeared in each. In *I* and *K* the daughter-nucleus on the right is shown at a slightly more advanced stage than the one on the left. There are now two cells in the same condition as the single cell *A* in the resting stage. Each of those two may divide in a similar manner, and so the process of cell-multiplication be continued.

tially gathered around the opposite poles of the nucleus, nature proceeds to divide the cell in the middle between them, so that the result of the whole process is that two separate cells are formed, each containing its own half of the nuclear matter, which in the case of the egg-cell is likewise composed of equal shares of the hereditary matter from both sexes. And so in this simple, mathematically exact yet mysterious way, nature goes on dividing and multiplying cells unto the perfection of the organic form. This process of cell-division is the method of all subsequent growth.

We will pass over the details of the further process of embryological development, — they are exactly described in the text-books of physiology; but in general this process of cell-division and cell-multiplication goes on in embryonic development after this manner: first a spherical layer of cells will be formed, surrounding a cavity (*blastula*); then these cells will be arranged in two layers, hollowed in, like a rubber ball pressed in from one side, forming a double-layered cup; then there follow still further groupings and differentiations of cells and layers of cells, until the adult form is fashioned. In this process, two quite distinct kinds of cells early appear; one of them are the germ cells, which shall serve the purpose of transmitting life with its hereditary properties; the other are the somatic, or body-cells, from which the tissues and frame and organs of the individual are built up.

Regarding this process of fertilization and development as one whole, we find at the beginning a simplest cell, like the little egg of the worm *Ascaris;* the method of growth is seen to be through successive divisions and multiplications of the cells; and at the end of it all, according to the nature of the ultra-microscopic matter of the egg-cell at the beginning, and as the full final revelation of its life, we find the specific adult creature, the worm, the fish, or bird, or mammal, yes, likewise, — for our life too belongs to nature and is cherished at her heart, — the human child. Such in brief is the evolution of life from the cell. Shall we hesitate to call such evolution revelation? It is revelation of something unseen. From the invisible comes forth the visible. The unknown makes itself known. We see the thing which is coming forth from the things which do not appear. The original mystery of the dispensation of matter and force takes living form and shape, and unfolds itself before our eyes. Our science may follow it part way, and describe it; it knows not the cause of it. Watching it, studying it, thinking over it, we ask, What is it which is here coming to revelation? And how is it disclosed? What is the method of this natural revelation through life?

If we look up from this single instance which I have been describing; if we survey the whole evolution, and consider it in the large, we are confronted with this same question, What is nature's method of revelation? Are there any principles of revelation which we may discover in the course of evolution? Are such principles of revelation to be found and followed throughout nature? Do they hold good in every realm of the creation? We have next, therefore, to observe certain characteristics of nature as a revelation. We shall search for the principles in the facts.

We find first that the principle of revelation in nature is one of self-revelation, — of revelation of itself from within. Evolution throughout is nature's self-revelation. The Life comes to the light in the development of the egg-cell. This disclosure may be of some power beneath or above nature; but the revelation of it, whatever its Name may be, comes from within nature, and through its life. It is light shining from within, and growing as the development proceeds. The mystery of the ages which envelops the egg-cell, is not suddenly lifted as a veil might be by some hand from without. No search-light from afar is flashed down into life's primal secret as it lies hidden darkly in nature's heart. We must wait, and watch for it to make known its own meaning. Neither is revelation, as it comes to us down the great world-process of evolution, like a sudden flash of reflected light, in which nature's original meaning and intent may be discerned; nature rather becomes self-luminous. Gradually, as the ages proceed, the mystery of the dispensation of life becomes manifest.

Moreover, this character of self-revelation pertains to evolution everywhere. It is a method running through all the orders of the world. The text of nature's sacred scripture grows from age to age; but no commentary is added, no note of explanation is ever appended. We must find out nature's meaning from her own text, and from the text only. The book of life is issued in successive chapters, and there is no break of meaning between them; but on every page it is to be read in its own language without help of translation; it is to be understood by comparison of its successive chapters, and interpreted in the completion of its one volume. If it has rational unity, that will be found in its whole order. If it has the characteristic of a process of thought, that will be discovered in the logic of its whole movement. If it has direction from the beginning and throughout its course toward some final end, that too will be disclosed in the succession of its forms. If in short, nature as one whole is characterized by intelligence and is informed with thought, its glory of reason will be revealed as the disclosure of its secret from of old, and as its own prophecy of its destiny. There is no other way of natural revelation than this way of self-revelation.

Evolution is a progressive revelation.

The method of revelation in evolution is marked by these two related characters, — it is, as has just been noted, an opening forth from within of the powers and promise of the creation; and it is further a progressive disclosure of them. Evolution, as one continuous course of nature, contains always both prophecies and fulfilments. Each successive chapter brings out further the meaning of preceding chapters, and points also to something to be made known in coming chapters. Evolution is a novel with a plot. It is a story which grows more interesting as we read on. It is a romance of life with love hinted at the beginning, and growing clearer through its varying fortunes and many perplexities, and becoming sure of itself as the story goes on.

This progressive character of natural revelation appears in a striking manner when we consider one of the noted discoveries of modern embryology. It has been observed that the growth of the individual in the egg repeats, or in some measure recapitulates, the successive stages of the development of the race. The individual sums up the history of his ancestors. This law of recapitulation cannot indeed be too closely followed in embryological growth, and it has sometimes been exaggerated and travestied in popular conceptions of it; as, for instance, when it is represented that "the human embryo is in one stage like a little fish, later like a little reptile, and so on." Mr. Milnes Marshall has expressed the truth in "a wide and metaphorical sense," when he said that "Every animal in its own development repeats its history, climbs up its own genealogical tree."[1] It is true that in a general, though usually a much abbreviated way, the later animals repeat in their embryonic growth stages which resemble earlier forms of life. Gill-slits, for instance, like those of a fish are to be seen in a chick a few hours old within the egg. The whole process of previous life is not repeated, and earlier forms are often overlaid by more recent adaptations; but, speaking broadly, the life-history of the previous ages is recapitulated in the embryonic growth of the later forms, and in the growth of the human child.

Now this habit of nature of summing up, as it were, lower chapters in the history of life at the beginning of new ones, is found invaluable to naturalists as an aid to their understanding of the course of evolution, and as a help to the right classification of different animal forms. Following nature's own summary, they are enabled to arrange better her forms in their true order, and they

[1] Thomson, *Science of Life*, p. 135.

find that these constitute a progressive series. For this is our point in referring to this habit of recapitulation in nature; — we have been helped to see by it that the evolution of life has been throughout a progressive revelation. As the process draws towards its completion, in the embryonic growth of the higher animals we can read the previous history backwards, and understand more truly its progress. Life in its last forms becomes a fulfilled prophecy, by means of which we may interpret words spoken of old by nature in the first inspirations of her up-reaching life. When the whole history is summed up, and put before us in its most complete form, we can perceive that it has been throughout an intelligible record, and that all its successive chapters and parts have had their place and time.

Evolution is increasing revelation to a growing organ of perception.

On the one side there is an increasing manifestation of nature, and on the other side there is growing capacity to receive the revelation. The fact that it is so, will appear when we consider how the natural world has gradually been disclosed to the eye which was forming to see it. Indeed one of the most interesting, but as yet unwritten chapters of popular science might be entitled, A Chapter on Eyes, and How they came to see. Only in scattered notices here and there in our scientific literature has this natural romance of the evolution of the eye been written, and it has not yet been made popular science. It is indeed a wonderful history — this strange story of growth from its earliest rudiments of the clear-seeing eye. The zoölogists from their comparative observations of all kinds of eyes have gathered much material for this scientific serial. Through its chief stages, and in many interesting particulars, the development of the most highly organized eye can now be followed; the genealogy, so to speak, of the eye may be traced. We will not attempt to describe it here with technical definition; but we will follow it sufficiently to show the truth of this characteristic of natural revelation now before us; viz., the revelation of nature increases as the capacity of perception for it grows.

All living matter is now known to have some sensitiveness to light. Some response to light has been shown to characterize even the primitive protoplasm of an *amœba*. And what is still more curious, that little dot of a being, without any organization to speak of, has been found to notice different kinds of light, for it will respond differently to different colors.[1] It will answer with the quickest responsive movement the stimulus of the red ray; it will answer somewhat less responsively the green and yellow rays. Its motions will be stopped or reversed by violet rays. It may be perhaps a question whether these differences in its response are not occasioned by the different degrees of intensity of the light rather than by the changing colors; but the experiments indicate that living matter in its primitive form has some sensitiveness even to color. As an *amœba*, however, has no special organ for any function of its little life, so it has no particular

[1] See *Am. Jour. of Phys. Aug.* 1899, pp. 9–18.

point of response to the light. It does not need it. But from this general primal sensitiveness of living matter to light, and under the stimulus of the light, the eye shall in time take form, and perfect vision come. In a minute microscopic organism (*Euglena*) — to which reference has already been made as half plant and half animal — there may be noticed at one end a small red speck, which is called an eye-spot. The name may seem almost fanciful, yet that spot is known to be sensitive to light. Some way farther along the scale of animal ascent, in many of the lowest mollusks veritable eye-spots are found. On their exposed epithelial surface certain pigment spots appear; the epithelial cells at these points become slightly elongated into a rod-like form, and we witness nature's first attempt to make a seeing eye. But in this simplest form there is as yet no vision — only an eye-spot, possessing special sensitiveness to light. A little more is gained for the coming faculty of vision when these pigmented spots of the outer membrane or skin become depressed, and form saucer-like pits in which the sunbeams are gathered up. The primitive eye is only a saucer — a sensitive saucer — for gathering sunbeams. Then this depression is deepened, and becomes like a cup, as in the eye of a limpet; and the nervous tissue beneath it begins to separate into distinguishable layers. Still thus far we have only a spot better fitted to perceive light, but not capable of distinguishing objects. The next step consists in closing up the cup which has been made, leaving just a pin-hole open for a beam of light to pass in; and then, having gone so far, nature seems easily to go a little farther, and covers the small opening with a transparent membrane. It is not quite closed in the *Nautilus*, it is closed and covered in the snail. Thus the common snail was a distinct acquisition to natural society with its better eye. This cup-like eye, so closed, is then filled with a transparent refractive substance, which may be regarded as the beginning of the vitreous humor. Now at length the image of an object becomes possible on the retina, which nature at the same time has been finishing at the bottom of the cup. Nature next manages to let a bit of cuticle grow into this cup-like eye, and to take form as a crystalline lens for better seeing. In the common squid we find the eye at this further stage of its formation; and indeed the growth of the eye in the embryo of the squid passes through, or recapitulates, the successive stages which have just been described. Nature has thus reached the best possible invertebrate eye. In its earlier forms sight may be a "pin-hole vision"; but it takes in something of the great outlying world, — enough at least for the uses of the life for which a nautilus may need to see. We need not follow with a too complicated technical description the further stages and diversifications in the later interesting development of the vertebrate eye. Its history branched off, and followed an improved method of its own. It has gradually grown to be what it is in our organ of sight. Its exceeding excellence is a slowly acquired perfection of vision. When at last it is gained, behold the full revelation which is opened to it! The earth and the sky at last are mirrored in the finished eye.

Reflect that throughout this evolution of the eye nature has been an increasing revelation to its growing perceptive power. There has been revelation of nature as fast as there was formed an eye to see nature. Only as much at any time can be disclosed of the great outlying world, as there exists at that stage of evolution an eye to perceive. To the rudimentary eye-cup only a dim sensation of some outlying reality can be given. Through the primitive eye-slit a vague perception of light beyond may be brought in; but the objects which lie in the world without do not yet appear. The worm, or the primitive mollusk must be a veritable agnostic, perceiving light, but seeing nothing in it. In the eye better fitted with a simple lens images of objects, although still vague and shadowy, may be depicted. There are some peculiarities of insect eyes which have led naturalists to suppose that possibly they may have some perceptions adapted to their needs, which we do not need, and do not have with our larger, better eyes. Through the eyes of the most developed animals, and to such degrees of sentience as they may possess, nature reveals not only distinct images of things, but also objects to be desired or avoided, the means of preserving life, ways of escape from danger, and the places best fitted for their existence. Nature reveals to them food, and whatever is needed for animal life in harmony with her provisions. Thus ever with increasing sentiency the revelation grows. At last through the eye of man, to the intelligence behind it, not only food and raiment, and all things needful for the maintenance of life are disclosed; but the veil is lifted from a realm of order and of beauty which had long been waiting to be revealed. Nature has formed at last the finished eye of intelligence to behold her perfect loveliness. In a fair landscape, or from a mountain-top, man sees a world which seems not to be opened to the eye of his dog or to the horse that will turn from the grandest prospect to the grass by the side of the path; man perceives a largeness of sunny space, a loveliness of color, a beauty of the fields and a splendor in the skies, which had been there waiting long for eye to see it. Nature's final revelation is to the open eye of intelligence; the poet looks on nature and feels

> "A presence that disturbs me with the joy
> Of elevated thoughts; a sense sublime
> Of something far more deeply interfused,
> Whose dwelling is the light of setting suns,
> And the round ocean, and the living air,
> And the blue sky, and in the mind of man,
> A motion and a spirit that impels
> All thinking things, all objects of all thought,
> And rolls through all things. Therefore am I still
> A lover of the meadows and the woods,
> And mountains; and of all that we behold
> From this green earth; of all the mighty world
> Of eye and ear."

Even at the risk of repetition we should fix clearly in mind, as of much importance, the double method of natural revelation which has thus been described, for in our subsequent inquiries we shall have frequent need to recur to it. Generalizing and stating it as a law of natural revelation, we have this principle: there is first progress in the development of the subject-matter which is to be known; and, secondly, there is progress in the faculty by which the matter to be disclosed may be known; and, thirdly, there is finer correspondence between these two. Evolution is at last revelation of formed nature to mind grown capable of apprehending it. We shall consider later on how much further this principle of natural revelation may carry us; — whether there may not be possible some further and fairer disclosure of nature to intelligence still better fitted than ours just now to receive it; whether things eye hath not seen nor ear heard, nor heart of man conceived, may not be preparing for some full, final manifestation of them to the children of the light and of the day — the creation's supreme and resplendent manifestation at last to the children of God.

It would lead somewhat beyond our present limits to carry this line of thought to its further issues in the recognition of the same principles of revelation throughout human history. A suggestion only of this further continuation of the same method of natural revelation in man's life will be sufficient for our immediate purpose.

In human history likewise revelation has been from within through the life; it has been gradual and progressive; and it continues still to be increasing manifestation of the Spirit of the Christ to the growing Christian sense of the world. The Bible, as our trained students of it are now teaching us, is a record of a divine revelation through a selected line of life. The supreme revelation of the Father has not been communicated to us from the sky above; it is not as the voice of the angel standing in the sun;[1] the Life was the light

[1] Rev. xix. 17.

of the world. The words of the Master seem to be self-luminous; and the Father is known through the Christ living among men. Nor has his disclosure of the truth ceased in the witness to him of the first disciples. His authority has been and is a living and hence a growing authority, deepening with the thoughts of men's hearts, and expanding with the life of the world. There were many things which the Christ could not say to his immediate disciples, because they could not receive them. Their capacity to perceive had not yet expanded to the full manifestation of the Spirit. They should know hereafter. Their spiritual eyes were not then perfectly grown to see all that the Master might reveal. As Christian history progresses and religious experience broadens, not only on the one hand is the truth more largely brought to light, but also Christian minds and hearts may be selected and formed, and still more finely trained to perceive it, and to become bright in it. In accordance with the first principles of natural revelation, which we have been studying, spiritual revelation, the manifestation of supernal truth to the spirit that is in man, has never ceased, and it shall continue to increase until the full day shall come. The Church, as the centuries pass, may gain a more seeing eye, a truer mind and a happier heart, for the ever-enlarging manifestation of redeeming Love; until at last there may be found on earth the pure heart for the vision of God.

To the individual, also, the same natural principles of revelation may apply; nature, history, the Bible, the present dispensation, may become to us increasing revelation, as in the personal life, and its growth in grace, we acquire clearer spiritual eyes to see the whole world lying in the full light of love. It will be at last a sunny world for the sunny eye to see. For there is profound truth alike of evolution and of its revelation in Goethe's saying that the eye must itself be sunny that would see the sun.

In this chapter we have been studying the method of natural revelation irrespective of the contents of revelation. It is necessary to inquire first as to the method of it before we can know the truths which it may contain. It will prove an immense gain for our faiths if we may first understand somewhat how nature may teach us, or in what ways we may expect to hear whatever the universe may have to say to us. In further chapters we shall follow on to know some of these words which in this manner of speech nature may have to declare ; we shall thus in a way which is scientifically true inquire how much these words of natural revelation may signify for our most human faiths and our dearest hope.

CHAPTER III

THE FACT OF DIRECTION IN NATURE

Having given in the last chapter some account of how nature speaks to us, or of the method of revelation through evolution, we pass next to a study of some of the chief words which nature may have to declare, as we ourselves have become intelligences sufficiently evolved to hear whatever nature is waiting to make known to us.

The first question — a vital one for the subsequent interpretation of nature — relates to the guidance of evolution: Does nature show direction towards any definite end? Has the created world rightly been compared to a ship which has been abandoned as a derelict upon the high seas, in itself evidently fitted up and ordered for some good voyage, yet left without helmsman to drift as an aimless world over the deeps of infinite space: or has the world received from the beginning definite direction toward some goal, and has it kept that direction throughout its age-long course, — is it keeping itself true to it now? As Mr. Ward tersely puts it, Is evolution "without guidance or with guidance"?

Observe, as a preliminary consideration, that any evidence which the course of nature may disclose of direction towards some end, is not to be set aside by any ignorance of ours concerning the nature of the end towards which all things may be moving. It would not follow that a ship may not be sailing on a predetermined course, because it may be sailing under sealed orders, and no one on board may know well its ultimate destination. Even if nature be under orders whose seal no man may break, nevertheless it may be moving on towards something which is yet to be revealed. The first question for us to determine is one of fact, whether it is moving along any definite, progressive course.

Neither would it necessarily follow that the course of visible nature may not be as a personally conducted tour, although the director of it, and organizer of it all, may be represented at different times only by his agents, and may never appear personally while the journey is being made. The main question relates primarily to the fact of direction in nature; then we may inquire next what may be learned of its character. If there is any evidence of guidance in evolution, we must find it in the evolution itself. Matter we know, and force we know: Does our science know anything of direction? of direction towards an end? Are there any signs that there is a directive touch guiding nature's course, although no directing hand may be visible to us? Or how shall such direction as we observe in nature be explained? Instead of confessing, "I believe in God the Father Almighty," it is easy to say, "I believe in Matter in Motion"; but will that short creed prove long enough to stretch around the facts which nature presents, as we are shown the ends of evolution which already nature has actually gained, and the process through which they have been reached?

Our human experience may be large enough, our positive knowledge may measure distance long enough along the way in which evolution has proceeded, to enable us to determine that as matter of fact there has been and is movement along some line; and to warrant us also in some inferences as to the character of this direction, whether its tendency on the whole is towards higher vital values and happier issues. Possessing for my habitation a bit of a river's shore, I may be able from my little space along its bank to perceive that there is a stream which flows one way, and not merely a succession of aimless, wind-swept waves, breaking upon the beach. I may know even from my brief life here that there is in nature's course a tendency, sure and strong, all in one direction; although I may know little or nothing of the fountains and far off springs of all this mighty motion, and can only dream of the outlet and some large hereafter, towards which all things seem hastening on. And if I may find from present observation reason to believe that nature does not resemble a stagnant pool, stirred only by the passing breezes; if I may perceive that human history is not as a heap of accidental sands swept together by ever-shifting winds, only to be scattered again; — this much of knowledge and of confidence will form the first essential article at least of a grand natural faith. For us to believe in matter without any idea in it, is materialism; to believe in matter with some idea in it is spiritualism. We can be satisfied to remain agnostics, only when we shall have searched through the material realm for the ideas of it, and have exhausted all the meanings which the facts of the universe and its evolution may possibly open up to us.

We shall have, therefore, to survey first the facts of evolution which indicate some direction; and then we may consider their higher interpretation. In this survey even slight signs, or apparently incidental facts of nature are not to be passed by; for, to apply to our purpose the line with which Dante began his progress through the spheres, if we find ourselves as "in a gloomy wood," "midway of this our mortal life," then certainly the trail which may lead out to some sunny opening, may best be followed by the eye from whose notice does not escape the least trace of footprint, or the bending of a blade of grass, or the occasional sunbeams through the thick leaves.

We proceed accordingly to take up next in some detail the facts which give indication of the direction which has actually been pursued through evolution. We shall go forward surely, if we can succeed in following slowly nature's way on and out.

There has been direction of motion in the inorganic world.

Evolution in the physical realm has started from some definite beginning, followed a determinate course, and reached at least a way-station of its progress in the world around us. The route may not always have been straightforward; at points it may seem to curve back upon itself; but there has been a continuous track all the way, and in pursuing it the energy of the universe has reached its present end in the world as it now exists for us. It is not scientifically conceived, if we should say, from millions of possibilities the physical universe has happened to take its existing form. The only conception which a thorough-going evolutionist should admit, is that from given primitive conditions the existing universe has resulted in a regular and causal sequence of events. We do not overlook in this connection an ingenious argument for the play of chance in the formation of the world, which in the supposed interests of freedom an eminent mathematician has devised. His supposition in favor of chance and against a universal mechanical necessity has been thus put forth: Of a hundred persons who start out to walk in many different directions, it is supposed that on a theory of mathematical chances it might come about that ten might walk in the same direction, and that any two of the ten, who also happen to walk at the same pace, might in time be found walking together. These companies of fellow-travellers, going two by two, would thus have been brought together by mere chance. So the atoms, it is imagined, starting out and travelling in their several ways, may have accidentally fallen into separate groups. So in molecular groups order may have arisen from a chance natural selection. The supposition is good as far as it goes. But it overlooks the stragglers. What has become of the ninety of the original hundred travellers who did not happen to fall into the same way or the same pace? The stragglers should also be in evidence somewhere along the road.

The unselected and unaccompanied wayfarers would also turn up as they pass irregularly along. But in our universe of order no such wayfarers appear anywhere. There are no straggling atoms; there are no solitary elements, so far as we know. It is everywhere order and uniformity, so far as appears. There is no limbo in nature for lost atoms. There is no apparent waste of energy in aborted possibilities of worlds.

The origin of things indeed lies beyond knowledge; that is something for us to think about, not to see. But the known fact is this: where things first come within our sight, they have already received definite form and determinate direction. They come into the field of knowledge as a procession of forms, keeping time and marching to their own music, like an ordered host.

The physicists suppose that the original condition of things was something very different from matter as we now have to deal with it. They suppose atomic matter to have been derived from some primal ether, which has its peculiar properties, very hard for us to comprehend; they describe it as a perfect fluid, the perfection of which seems to consist in its not possessing the ordinary characteristics which we mean by the word fluid. But whatever this first estate and original innocence of ethereal matter was, certainly at the first point where our science may lay hold of it, it has already acquired very definite characters and fixed habits; it has been put under bonds to its own constitution, and in all its subsequent motions it must follow the laws of its structure. In a word, our knowledge of the universe begins with energy which has already acquired definite direction. It is not energy which is free to take form in indefinite chance creations; it is energy already harnessed to an idea, and sent towards the very end which has actually been attained in the existing physical universe. Moreover, so determinate is the energy of the world that we may follow scientifically the evolution of the physical universe step by step with much plausibility. The course of it runs forwards, concrete and definite, as a railway track; and we can name several of its way-stations. The first is known as the atom. According to our best scientific imagination an atom is a vortex-ring, — a whirl of ether. The atoms are so many original whirls. Atomic matter is nature's first dance. When two atoms dance together, when two ethereal whirls are made one, then the molecule is formed. It may be an unstable combination. Partners are changed, and doubtless it took some ages for them to settle down into stable and harmonious relations. But in time, and under cooling temperature, one after another of the seventy or more elements of the physical order were formed. Then masses of elemental matter, so constituted, take shape and position; nebulæ, meteorites, stars appear; the ancient order of the heavens was born. Has not Professor Lockyer traced out for our wondering gaze the evolution of the stars? And on this earth the physical process continued as it was determined; bodies composed of different elements appeared in permanent forms; crystallization occurred, the diamond is pressed into being. The geologists have discovered also a corresponding order of evolution in the development of the successive geological faunæ. It is described by Professor Le Conte as a general movement upwards and onwards, with diversity of direction and rate of motion in different localities, and with re-adjustments and re-distributions of faunæ at critical epochs.[1] It is a long distance between the mathematically imagined perfect fluid at the start, and the existent earth, with its diversified physical constitution, its mountains, and rivers, and fields, and oceans, and its precious stones, — a world fitted for life and ministered unto by all the heavens; — but this is the end which has been reached; it is a physical and climatic end which renders life possible on the surface of a world; and to this end the evolution has been sent from the beginning. The direction throughout towards this goal is not itself an accidental by-play of the evolution; rather it is the character of the evolution as one whole. And character is always something ideal. The course of the evolution apparently has the character of an idea: it is like a process of thought; it has moved on from a beginning to an end, as a process of thought moves on. The constellations are crystallizations of God's thought. But we are asserting at this point only the ideal appearance of the process as a whole of inorganic evolution.

A further known characteristic of physical evolution is next to be noticed; viz., the passing its work on to the higher vital order. When the physical evolution of the world had gone apparently as far as it could in its own way, it did not stop and turn back upon itself; it handed its energy over to another, a promising order

[1] *Popular Science Monthly*, March, 1900.

of evolution beyond itself. Or rather we should say, the original energy which had been manifesting itself in the evolution of the physical world, when that was finished, and nothing much better was to be gained on that field, did not stop, and turn back; it went on in a new conveyance, in a more excellent way, towards the promise of organic evolution.

A traveller hastening on his way may have to make several changes in his carriage before he reaches his destination. He may take now a railway, or a steamship, or other means of conveyance, transferring himself from one to another, in order to reach his journey's end. Similarly, evolution, or the energy of evolution, has seemed like a traveller who changes at times his carriage, but keeps pressing always towards his goal. Energy has been handed over, energy has been passed up from one order to another. It has passed from the ethereal mode of it to the atomic: it has been transferred from the molecular to the vital conveyance of it. And moreover it is profoundly significant, that just when the energy of evolution seems to have gone as far as it can in one way, and must stop, and turn back, or make a new departure, then it takes a fresh start in another order. The atom was a new departure, and by means of the atoms the creation was carried on out of the ether up to the fixed stars. Life on the earth was a new start. The first bit of protoplasm, however it originated, marked the end of definite movement on one plane of nature, and the continuation of it in a new direction, on another line and towards something not attainable on the lower plane, but to be reached in time, far beyond all that had been before it. Protoplasm — the coming of the protoplasmic order — is the beginning of a new reign, and the promise and potency of a glory yet to be revealed. When the first living cell appeared in some far off geologic time, it was nature's prophecy of the new earth; — behold! the wilderness shall blossom as the rose, and the stream of the molecules shall become as the river of the water of life.

We turn now to this further and still more significant indication of guidance in nature, — the Fact of Direction in the Organic World.

We will search first for the evidence of it within the living cell. For if there appears to be direction in the movements of the cell, we may look for providence of a similar kind in the affairs of the world. Or, conversely, it might be put: If we have reason to believe that there is any providence in the great outlying world, we may look for direction also within the least cell. The internal ordering of the cell may present providence in miniature. We may scientifically apply to the divine providence the test which Jesus applied to the conduct of his disciples, and say that if it is faithful in that which is least it will be faithful also in that which is greatest. Nor can we separate in our reasonings the problem of providence in the least and in the greatest; through the microscope and the telescope, over the broad ranges of history, and in the beating of our hearts, it is one and the same problem of the rational direction and moral guidance of life. Hence if we would interpret the cell aright, we must not only examine it under the microscope; we must focus also upon its mystery all our light of life; and, conversely, the little living cell may have its contribution, not to be despised, to make to our spiritual philosophy of life.

We have already given a general description of the structure of the cell. Our present point is that living matter in its lowest power, far back as we may know it, has already received definite structure. In its least dimensions it is defined, determinate, organized matter. A mere enumeration of the different parts and elements which appear in a cell during its life-history is sufficient to impress this fact upon us; we will read them off, as they are technically named, simply by the enumeration to show what an assembly of definite parts, fitted to each other, lie packed in the cell. They are the cell-wall, the cytoplasm, or cell-matter; the nucleus, the nuclear membrane, the nucleolus, the attraction spheres, the centrosomes, and even smaller dots, the centrioles, within these, the chromatin matter, the chromosomes, the polar bodies, the asters, the spindle fibres, the linin threads, the protoplasmic granules, the cell-plate, and some other things not quite distinguishable enough as yet to be named.[1] You perceive what a complicated factory world this microscopic sphere is, and from it, in response to calls from the outer world, issue all the variegated and rich patterns of life's ceaseless weaving.

Now the significant fact to which in this connection attention should be directed is this: what this egg-cell produces has already been determined by its organiza-

[1] See Figure 1, p. 31; and 2, p. 34.

tion. It is so put together, its several parts so related, and their mutual working so adjusted, that it produces regularly certain definite results. It is so much matter well organized for work. Because it is made as it is, it does what it does. Direction has already been given to it. Our first knowledge of life is knowledge of matter which has been brought under some control for certain ends.

On the very threshold then of the organic realm the question meets us, How is this fact of organization to be understood? From whence did it come? What does it mean? To what has it been sent? In other words, at the first point in the way of life where science may enter it, we observe this sign of direction, — organization for a result; how was that sign set up there, and what does it signify? This little cell-world does not come out of the unknown as a fortuitous heap of atoms; it is not a chaos without form and void. It is a thoughtful growth. Some Spirit has brooded over the living cell; some Power has directed it along its way of life. Herein lies the wonder, the first natural miracle, shall we call it? of matter definitely formed and organized for the exercise of specific functions in the development of life. Certain energies, whatever they may be, have been marshalled within this limited field, and led in distinct and intelligible formation for the coming conflict of life, as much so as any regiments drawn up in array for the battle. These vital atoms are no mob force. They have been drilled, and given their place, and they keep true time and obey their orders. The individual units may be changed, some may fall away; but the lines of the formation are kept, and shall not be lost in the whole subsequent struggle of life. In short, it is a primal fact, which waits to be interpreted, that matter has acquired definite vital direction in the egg-cell.

We have thus far been dealing with nature's vital elements and observing the signs which they show that they are sent to some purpose, as they begin life's mission upon the earth. We proceed further to inquire what nature next does with them, and how she contrives to make the most of them. The lowest animals, the least of all nature's children of promise, are organisms which consist of but single cells — the so-called unicellular organisms. Sir Fowell Buxton once attributed his success in life to his habit of being a whole man to one thing at a time. The same may be said of the primitive unicellular organisms, for they owe their success in life to a similar principle. An *amœba* can be nothing else than a whole cell to one thing at a time. Without mouth, or stomach, or any separate organs, it manages to feed simply by throwing itself around and engulfing the particle whose nutriment it absorbs. But nature does not remain long in that primitive undifferentiated condition. It proceeds soon to combine and to diversify its original units. A principle of division of labor appears very early, and as we follow up this new way of the distinction and combination of parts for the production of better vital results, we shall mark increasing evidences of some direction in nature. Very soon in the history of life an idea of growth, the fine constructive idea of growth through the division of labor, seems to have been introduced. The beginnings of this new tendency may be traced even in the one-celled organisms; for in the *Infusoria* — minute animalcules which will swarm in an infusion of hay — there begin to be distinguishable something like a mouth, and food vacuoles, or temporary holes at least for digestion, and some other rudiments of different parts. One of the first noticeable steps in this direction of the division of labor is to be seen in aggregations of cells in one living mass. Near the beginnings of the vegetable world there is to be found a small transparent ball of jelly, in which several spherical particles lie embedded, which upon investigation prove to be living substances conveniently rolled up together in the same globule, but still separated from one another. We see here in its primitive form a collective life of cells. It seems to be nature's first attempt at socialism — a mere collection of individuals loosely bound together, hardly as yet a working colony of cells. But that soon comes upon life's stage. For in some other quite primitive forms individual cells have not only been collected together, but they have thrown out threads of protoplasm by means of which they become loosely interwoven; as in a species which for this reason has received the scientific name of *Mikrogromia socialis* — the social Mikrogromia.[1] Nature makes another early effort in the direction of social existence in certain forms in which separate cells seem to have run together and become one large protoplasmic mass, but with several distinct nuclei, as in the fungus growth called Myxomycetes; and this primitive kind of

[1] Hertwig, *Die Zelle und die Gewebe*, B. ii. s. 11.

associated life, is frequently met with near the beginnings of the vegetal and animal world.[1]

Thus far, however, up the scale the separate cells are only associated together, but have as yet attained no distinctive functions, and no very definite and permanent division of labor between them has been as yet arranged. But nature, having gone thus far, proceeds straight on in the same direction; above the first class of unicellular organisms, and just beyond these primitive approaches towards the communal life among them, which we have observed, there has come into existence a second distinct class of animal organisms, composed of several cells, which begin to assume mutual and more and more definite organic relations to one another. This class in distinction from the first class, the *protozoa*, is called the *metazoa;* several zooids, or animal units, are united in a mutual life. But the vital association of cells in one organism is a very primitive connection — a quite informal gathering — when we first catch sight of it in nature. It may consist at first simply of a binding together of a series of independent cells upon a common stock, like blossoms upon a single stem; as in the instance of a beautiful early flower of life, known by the hard scientific name of *Zoothamnium arbuscula*, — the tree-like creature, — which consists of a main stem giving off several branches, on each of which numerous bell-shaped animalcules, "like foxgloves or Canterbury bells," are borne. It is a compound organism, and exists in its lowly loveliness as another and pleasing sign of the direction which nature is following towards

[1] Hertwig, *Die Zelle und die Gewebe*, B. ii. s. 14.

organized life. In this specimen, moreover, we find still another indication of advance along this same line, for the blossoms, or zooids, as the living units are called, are seen on close inspection to be not all quite alike. Most of them are bell-shaped, but here and there among them are found larger bodies of a globular form, and in some other respects different from the rest. They cannot draw in nourishment as do the others; but if we watch them we shall see that they have acquired a function and a use of their own; for they will become detached from the parent stock, "swim about freely for a time, then settle down, develop a stalk and mouth, and finally, by repeated fission, give rise to the new adult, tree-like colony." This sign shows that nature, proceeding with quiet determination in the direction of organization, has now clearly, unmistakably introduced the method never afterwards to be abandoned of division of labor. The same tree-stock has produced two kinds of cells — nutritive zooids, and reproductive zooids.[1] Associated life in two kinds has been humbly begun; and once begun it will continue on the earth as the more excellent way. We pause to note the importance of this fact. The advent of life in two kinds, vegetative and sexual, is one of early nature's great events. A principle of utmost value for the development of life has thus been quietly introduced. The division of living matter into two complementary parts — the nutritive and the reproductive cells — shall erelong become the prevailing and more and more elaborate method of vital evolution. In this far off and humblest

[1] Parker, *Elem. Biol.* pp. 134 *sq.*

beginning of sex in these primitive colonies of cells, lies the first promise and potency even of our human life in the help-mating and help-meeting of man and woman. This principle of mutuality, this fine idea of division of labor and of mutual service, once gained in nature, shall be carried clear through to its human consummation. What God in the beginning hath thus joined together even in life's first motions, cannot henceforth be put asunder.

This new and better way of mutually helpful life having once been entered into, nature follows it up vigorously with ever fresh, more differentiated and mutually dependent forms. Not far removed from the primitive colonies just described is another creature, the *Siphonophores*[1] in which the division of labor becomes a little more marked and enduring between different parts which grow together on the same tree-like stock; some of them serve the whole for the purpose of swimming, some for feeding, and others for reproducing the species. As nature hastens on through these gradations it reaches in time organisms which show in their development distinct layers of cells, from which entirely different organs for definite use, but in mutual dependence, may be developed. The common hydras, or polypes, mark the beginnings of this further course of evolution of separate but mutually serviceable organs in one body; and so the process in this good direction, according to this happy idea of nature, goes on and on until in the higher animals and in our own anatomy we reach the end and perfection of this long way of organization for life. It has been a long way from the two layers of

[1] Hertwig. *Die Zelle und die Gewebe*, p. 18.

cells in a polype to the many associated organs in the body of a man; but nature has followed this way, and in some manner has been directed through this one way, and held to its course; and the end which is reached justifies the direction which from the start has been taken. The introduction and growth of the principle of division of labor, marks, we are reasoning, one definite line of direction which evolution has actually taken. It is a course of nature from something to something, which may be scientifically drawn.

Other lines of direction which may be traced on nature's map, we shall next follow up; and then with the facts well before us from the least to the greatest, we may reason with more confidence concerning the character of the guidance of evolution. We may then be able to judge who was the better reasoner, Kepler, the astronomer, or his wife in their discussion of the salad at their supper-table: "Yesterday," the astronomer relates, "when weary with writing, and my mind quite dusty with considering the atoms, I was called to supper, and a salad I had asked for, was set before me. It seems then, I said, that if pewter dishes, leaves of lettuce, grains of salt, drops of vinegar and oil, and slices of eggs, had been floating about in the air from all eternity, it might at last happen by chance that there would come a salad. 'Yes,' said my wife, 'but not so nice and well dressed as this of mine is.'" If it requires intelligence to make so nice a salad, perhaps we may find good reason to suspect that Mind may have had considerable part to play in the evolution of such a world as ours.

CHAPTER IV

DIRECTION IN THE HISTORY OF LIVING CELLS

In the last chapter we traced the indications of some directing agency through inorganic development, in the earliest organization of life within the cell, and still further in the association of cells in colonies, and the advancing organization of the vegetal and animal world upon the principle of division of labor and mutual service. The signs of some direction in evolution will become apparent again and distinct, if we follow more particularly the embryological development of living matter from its beginnings in the egg-cell through its successive stages to the full grown adult form. We shall discover impressive evidences that some thing determines and guides evolution, if with pure and reverent eyes we gaze into the mystery of the reproduction of plant and animal life. Amid secrets of origins which eye cannot see, and from a sacred mystery of birth and inheritance which no science can wholly remove, one truth becomes clear and sure, — the truth that there is a predetermined and specific direction of every species and of each organ of the body in the prenatal development of life. Embryological development follows with unwavering fidelity fixed lines of growth. Embryology is one of the exact sciences because it rests upon these primal fidelities of living nature to the decrees of perfection which are already determined within the egg-cell.

It is now scientifically known that a few dots of microscopic matter, more or less, within the egg, determine the whole subsequent life-history; and further that from these determinants put at the beginning in the egg, — an exact number of them for each species, — the embryological development proceeds with an unvarying constancy in response to the environment. Two facts here are significant. The one is this: for each species the number of chromosomes in the nucleus of the egg-cell is always the same. The chromosomes, as we have seen, are the loops of darkly staining matter in the cell, which are exactly halved in each division of it.[1] Now the remarkable discovery has been made that these chromosomes vary in number with different species, but that in every egg for each species the same number of them is to be counted. Each species has its specific number of chromosomes which regularly recurs in the division of all of its cells, and from which no variations are known to occur. For instance — to mention a few so as to make this characteristic stand clearly out — the egg of the worm *Ascaris*, one variety of it, has two chromosomes; in the egg of the mouse the number is twenty-four, and a similar number characterizes also the trout and the lily; in he egg of the grasshopper the number is twelve; in the ovum of the ox sixteen; of man the same number, or possibly more.[2]

[1] See Figure 2, p. 34.

[2] Wilson, *The Cell*, p. 67, 206.

The constancy of these specific loops of matter within the egg, is almost startling in its significance. By them for every species the adult form is predetermined long before birth, far back in the darkness from which the light of life shall dawn. The direction was taken very early before it was light. A specific, unmistakable sign of the way in which life is to go, has been put by nature far away toward the beginnings in every least egg. The sign consists of a dot or two, more or less, of matter which itself is more definitely constituted than any microscope can disclose. These eggs, by virtue of the number of their chromosomes, are so many specific words of life; and each of them is spelled always with the same number of letters. By means of certain minute particles of matter, and their arrangement within the nucleus, the question has been already settled for each egg into what it shall grow, — a thread of grass, a worm, a deer in the forest, a bird in the air, — a child in a human home.

The other of the two facts, indicative of direction, which are to be found in the study of embryology, will appear as follows. After development has started in each egg according to its kind, as determined by its specific organization, biology can trace with great particularity through successive stages the process of embryonic growth. And in this growth likewise everything goes on with precision, and along definite lines. Observers have succeeded in following the course of the cells in successive divisions, so that to some extent they can trace the lineage of the original cells in the forming tissues and organs. The descent of the several organs of the body from original layers of cells, is now a demonstrated fact of physiology. It is unnecessary to describe in these pages the exact and interesting details which are given in full in our latest text-books of physiology.

Moreover, comparative physiology seeks to demonstrate how far in the development of different species these lines of cell-growth run parallel, and where they diverge from each other; and it is a well ascertained fact that in every species, either of plants or of animals, the direction of developing life which has once been taken, is never afterwards missed; it is nowhere abandoned for another; the right ways of growth for that specific form are followed with unerring combinations of cells, and with sure arrangements and co-ordination of the developing parts. At this point a new question emerges, and one which it puzzles our investigators to answer. How is it that these separate cells, which we have discovered in the marvel of their individual existence, have come to work so perfectly together? How has it come to pass that their cleavages are adapted to each other, so that they multiply and grow together, in the unity of embryonic growth? What co-ordinates them? What directs them to form all together one body? Professor Wilson rightly observes, "There is at present no biological question of greater moment than the means by which the individual cell-activities are co-ordinated and the organic unity of the body maintained."[1] If this question is of prime importance from a purely biological position, it is even more significant from the philosophical point of view.

[1] *Opus cit.* p. 58.

Keeping to our method of asking first for the facts, we inquire what is known as to the mutual relations and physiological action of these many cells which constitute a single body. We must answer, not much as yet is known. The cells of a tissue like a muscle, for instance, appear to be separated from one another by a non-living intercellular substance — the cell walls. But it is not certain that they are so severed, and some organic connections seem to have been traced between them. Some observers have detected fine protoplasmic threads, or intercellular bridges, between different cells. It is held that some organic continuity between the protoplasm of the cells, although not true of all the cells in the adult body, is more probably true of the earlier embryonic stages. One of our American workers in this field asserts that she has actually seen in the egg of an *echinoderm* the separated cells and groups of cells (*blastomeres*) spinning fine filaments of protoplasm, by which direct protoplasmic continuity is established between them after each division.[1] The evidence, which is accumulating in this direction, may lead our science to the view that a living body is practically a continuous mass of protoplasm, and that the individual cells of it are, as Professor Wilson suggests, "local centres of a formative power pervading the growing mass as a whole."[2] But what then is this formative power of the organism as one living whole?

There are some biologists who are inclined to lay

[1] Mrs. E. A. Andrews, *The Living Substance*, Sup. to *Jour. of Morphology*, v, xii. No. 2.

[2] Wilson, *The Cell*, p. 59.

increasing stress upon this influence of the organism as a whole over the parts of which it is formed.[1] Their position is defined as that of the "organism standpoint."[2] They maintain that the body as a whole has some determinative influence over the growth of its parts. One characteristic of this direction of the individual cells by the organism as a whole, if this be the true biological view, appears to be especially noteworthy, — the manner, namely, in which different phases of the embryological development are timed to each other. The timing of things together is always an interesting aspect of our observation of life. One of the signal indications of providence in the world at large and in the biographies of men is afforded by just the right timing of things, so that at the effective moment different events from widely separated quarters are seen to converge, and independent forces are found working together for good. This right coincidence of things for us is often remarkable in our individual experiences. How often it has happened that gates, at which we may have long been knocking, have remained closed, as though there were no friendly Presence within to heed our importunate need; and then suddenly, when we have been almost ready to despair, some unexpected conjunction of circumstances has occurred, a door of opportunity just at the right moment has opened, as though swung by unseen hands, and we have entered into life. We say that was providential. Now far back near life's beginnings a regular and remarkable timing together of different pro-

[1] See Child, C. M., *Wood's Holl, Biol. Lectures*, 1899, pp. 232 *sq.*
[2] *Ibid.* p. 235.

cesses appears in the development of the egg-cell. In the great world the hands are set together when some signal hour of history is striking; and in this miniature world, at the critical points in the development of life within the microcosm, the hands are set together, the time is kept right to the very second, and all goes well. This phenomenon of the mutually adaptive growth of cells in the time-rate of their appearance, may be observed in several ways and in numerous instances. In general, the cells multiply and take up their related positions just as fast and no faster than they are needed to keep the different parts of the embryo of a chick in the egg, for instance, in right relations and in normal size and co-ordination. And, in particular, special differentiations appear at the times when the organism as a whole has need of them. One of the workers in this field, who has noted the relative time of the appearance of different parts in the development of the lower annelids and mollusks emphasizes the fact that "the division of a single cell at other than the proper time would in many cases disarrange the whole complex."[1] He remarks that "the relative time of differentiation of various organs, and especially of the early larval organs, such as the prototroch, affords to my mind a most striking example of the interrelation of all parts of the developing egg."[2] He observes that in each case the differentiation occurs at such a time that the parts, which he has been studying, shall be prepared to perform their function when called upon by the environment. For instance, where the larva

[1] Child, C. M., *Wood's Holl, Biol. Lectures*, 1899, p. 233.
[2] *Ibid.* p. 242.

swims at a very early stage, the cilia, the hairlike oars, that is, by which it swims appear correspondingly early. But in other cases the matter from which these cilia are put forth (*trochoblasts*) remains apparently at rest, perhaps for a long while, until, some time before they are needed, the differentiation takes place. He says: "The energy of the egg is so exactly distributed that none is wasted in the development of organs before they are needed." "The different time relations in the division of the various cells indicate the nicest adjustment to prevailing conditions."[1] It is no wonder that this investigator finds in such timing of the cells to one another and to their mutual work, evidence of the closest relation between the different parts of the organism. But the fundamental question abides: How have the parts become so timed? What is the mechanism involved in it? And what Power has set the hands together to keep true time on this microscopic clock?

We glance here down a very interesting line of investigation which our biologists have not as yet followed through. The facts already observed, however, are certainly striking. For example, a recent number of a botanical magazine contains an account of some studies in the development of slime-molds, which are organisms of a low order. These researches show that in one species examined the division of the cell-substance and the cleavage of the nucleus are not brought about simultaneously by the same apparatus, and are in their mechanism independent. Yet the two processes are so timed together as to secure a constant result.[2]

[1] See Child, C. M., *Wood's Holl, Biol. Lectures*, 1899, p. 243.

[2] See *Bot. Gazette*, October, 1900, pp. 225 *sq.*

Again, Mr. Lillie from his studies of the lineage of cells in one of the fresh-water bivalves concludes not only that the direction and the rate of cleavage of the divisions of cells are correlated, but also that the sizes of the earlier-formed cells in this process of cell-division are directly related to the future adult parts.[1] Professor Wilson also is so impressed with the precision of the successive phenomena in the cleavage products of the developing egg that he writes of it in this manner: "In this regard the cleavage of the ovum often goes forward with a wonderful clock-like precision, giving the impression of a strictly ordered series in which every division plays a definite *rôle* and has a fixed relation to all that precedes and follows it."[2]

From this general sketch of the processes through which life increases, acquires distinct organs, and is wondrously built up and adapted to specific uses, we proceed to consider such explanations of these determinations of nature as may have been scientifically suggested.

A first biological duty is to find out as much as can be known of the mechanism of life. How are the several parts of a cell or an organism physically put together,

[1] *Wood's Holl, Biol. Lectures*, 1898, pp. 43–66: *Morph. Journal*, X. 1895. This view is confirmed also by Wilson and others, *The Cell*, p. 378.

[2] *The Cell*, p. 378. See also Dr. O. L. Zur Strassen, *Factors in Morphogenesis*, *Jour. Roy. Mic. Soc.*, October, 1899, p. 469. *Zool. Cent. Blatt*, vi. 1899, pp. 400–402. He holds that the really determinative factor is the fine internal mechanism. "It is as if the segmentation cell had a guiding instinct." This is illustrated by cases where the blastomeres move spontaneously but definitely. Tensions and pressures are insufficient to explain the changes of form and the cytotropic wanderings.

and made to work as a living mechanism? When however we search the scientific magazines for an answer to this question we shall find ourselves often reminded of the builders of Babel; for our biologists speak in different tongues, inventing many and uncouth names for the same things, and they often succeed admirably in putting one another to confusion. Nevertheless, with some careful attention on our part, the main theories which they have to suggest may be understood.

As one theory, the effort is made to analyze and to account for living processes by applying to them the laws of mathematical physics. Starting, that is, with certain living molecules as the elements of life's problem, we are to understand their transformations upon purely physical principles, by means of mathematical computations of stress and strain, and the relative position of these particles in space. The phenomena of life in short are to be quantitatively studied as a complicated series of mathematical equations.

Another main direction which the investigation of vital processes pursues, is the determination of their chemical constitution and processes. This is the appointed task of chemical physiology. Given the vital chemical elements, or units, we seek to know more precisely how they may combine, and dissolve, and recombine, and what may come forth from such very complex and unstable chemical conditions. These two researches, the physical and the chemical, are not opposed, but parallel investigations; and when their results are summed up in some attempted formula for life, they yield a physico-chemical description of it. In this way we seek to render a purely mechanical account of vital phenomena. This investigation is naturally the first one that should be made; and biology must constantly return to it in order to keep in close touch with the facts. It is doing scientifically what the child does spontaneously, when it pulls a flower or a plaything to pieces to see how it is made, or works. Certainly some progress has been gained in this mechanical account of vital operations, and up to a certain point the conduct of living matter may be brought under mechanical conceptions; for it is matter, as any engine is material; and it is composed of subtle chemical complexes stored with energy, as any working machine is a means of transference of energy. The molecules of a living body remain physical quantities; or perhaps it would come nearer our exceedingly abstract physical science nowadays to speak of them more respectfully as so many physical ideas. The curious experiments which biologists have made in shaking eggs, for instance, into pieces, or in putting them in different geometric positions and under various compressions, or even in setting the mechanism of fertilization going and keeping it up for a little while by treating some eggs with special chemical stimuli, — all these ingenious manipulations of the vital units afford some definite results, and serve to throw light over the mechanical side of life. Something indeed looking like the mechanism of cell-division has been produced by a skilful imitative manipulation of drops of oil, and the venture has been made of constructing wire models of this vital mechanism. We may expect that with still more exact minuteness of measurement, and with even subtler refinement of chemical research, we may learn more of the mechanics of the infinitely small. But it is another question which we shall take up later on, whether mathematics, in the utmost extension of its physical rule, can explain the concrete reality of the whole world, or of a single atom of it.

Proceeding from such knowledge as may be had of the physico-chemical side of life, biology finds the larger question opening before it: How has the mechanism of life been worked as a whole, and how are the methods or laws of its working to be formulated? This larger problem is not scientific in the stricter sense; it is partly philosophical; for it is an endeavor to discover the rationale of the machine. In this connection it is a noteworthy fact, as one of the American biologists, Professor Osborn, has remarked that "the basis of our modern methods of studying the evolution problem was established not by the early naturalists, nor by the speculative writers, but by the philosophers. They alone were upon the main track of modern thought."[1]

We must turn, accordingly, for further light upon the facts of direction in nature which we have been surveying, to our modern scientific philosophies of evolution. Since Darwin, however, evolutionists seem to be farther and farther at sea in their theories of evolution. They may all come into the same port together some day, but they are sailing on quite different courses at the present hour. Let us return to nature, let us be

[1] As quoted in the *Science of Life*, Thomson, p. 216.

sceptical at present of all theories and explanations, — that is becoming to-day the prevailing cry in this whole field of scientific research. The workers in it are agreed in the first article of the evolutionary creed, viz., the doctrine of descent; they believe with scientific unanimity in the genetic descent of all living creatures as a continuous process under natural laws. But they are further than ever from agreement as to the factors of evolution, or as to the relative parts to be assigned to different factors in the descent of life. They are agreed generally as to the validity of Darwin's great generalization, the law of natural selection; they are not at all agreed as to the extent of the reign of that law, or its sufficiency in the evolution of the organic kingdom. They are unanimous in their general conception of evolution as the method by which the unity of nature has been secured; they differ in their ideas concerning the forces of evolution, known or unknown, which are the efficient causes of the rich manifoldness of the world. If we seek to classify these divergent views, to bring into some order these variant theories, three conceptions of the evolutionary method may be mentioned as now pre-eminent.

The first is the view of the New Darwinians. They bring to the front the principle of natural selection as the chief law of evolution. The principle of the survival of the fit, or more accurately of the extermination of the unfit, is so well known that we need not delay to illustrate it. Mr. Darwin perceived and demonstrated its working in many before unobserved and unsuspected ways; — that was his great merit. But the newer Darwinians go beyond the master in their extension and application of his law. They hold not only that the struggle of existence occurs between organisms and their surroundings, but also that a conflict takes place between their parts. They carry this principle of conflict and survival even within the cell and among the determinants of the germ. Natural selection is to Weismann the all-sufficient principle — the skeleton key, as it were, which fits every lock, and opens any door in nature. If other factors enter, they play a subordinate part. Everything, according to this view, from the initial struggle of life within the egg-cell up to the most specialized and perfected animal form, has been determined under the sufficient principle of natural selection. One might roughly describe, without intending to caricature, this philosophy of evolution by saying that the egg-cell is nature's secret caucus, where everything is well arranged beforehand, her successful candidates picked out, and her subsequent proceedings determined; and that therein the one principle of natural selection is the controlling boss. According to this theory only germinal variations, or modifications which transpire within the germinal matter of a body, are perpetuated and selected; individual modifications of the body or its organs count for nothing. Bodily characteristics, such as the mutilation of a part, or the acquired skill of a pianist's fingers, cannot be directly transmitted to the offspring. Everything that comes to pass on nature's field of life has first to go through the secret caucus within the germ-cell.

This theory — Weismann's speculation — which we will not attempt now to follow further into its abstruse details, is a marvel of scientific ingenuity. As one reads it in Weismann's own writings rather than in the statements which others have given of it, he cannot fail to be impressed with the masterly intellectual process in which it has been wrought out; but it is too artificially constructed to endure, and it raises at many points more difficulties than it removes. Weismann began his great work with the perception that we have no theory of heredity, and he sought to find one. The failure of the theory which he elaborated to command general scientific assent, only emphasizes anew his original remark, "We have no theory of heredity."

We have, however, a second school of modern philosophic observers — the Neo-Lamarckians. Lamarck asserted that variations in organs may be occasioned by use or disuse, as a muscle may be increased by exercise, or a neck possibly lengthened in time by overmuch stretching; and Lamarck assumed that such bodily modifications may be transmitted to offspring, and so added to the stock by inheritance. Weismann challenged that assumption. But the Neo-Lamarckians maintain strictly the inheritance of acquired bodily modifications, and consequently they are disposed to relegate the principle of natural selection to a secondary place, while they make more of inherent forces of organic growth. They hold that the natural growth of an organism, its inherent growth-force, tends towards vital adaptations, in response to outward influences, and hence to progress in the line of definite and cumulative variations. Their answer concerning the method of evolution, broadly speaking, would be this: Progressive evolution has taken place through increasing structural adaptations to the environment, according to the inherent or self-adaptive powers of an organism, aided perhaps at times by natural selection.

Besides these two conflicting views a third view, or rather a third class of views is coming into biological favor. These conceptions may be regarded as mediating theories between the other two. It has been suggested by Mr. Lloyd Morgan and others, that although acquired bodily modifications may not be directly transmitted and inherited, they may be indirectly; modifications in the body-cells may work together with germinal variations as a favorable environment for them, and so in many instances what the individual acquires in his own body may indirectly at least count for something in the line of descent for his offspring.[1] Perhaps the biological philosophy, or conception of the method of evolution now most in favor is that represented by the German, Oscar Hertwig, and others who hold similar views: evolution is due, they would tell us, not to one, but to many factors; its law is not simply that of natural selection; it is that, and other laws combined with it. Life in its development and perfecting is a response to many influences, and its history is to be understood only as we shall discover and trace the co-operation of many factors, external and internal, in its evolu-

[1] See among the most recent writers, Prof. J. C. Ewart, *The Experimental Study of Variation*, Nature, Sept. 12, 1901, pp. 482 *sq.* He regards the soma as the immediate environment of the germ-cells, and thinks that variations of the germ-cells may result from the direct action on them of their immediate environment.

tion.[1] We are by no means sure that we know them all. There are signs here and there, some think, of an unknown power in evolution. The advancing line of life is the meeting-point of inner and outward potencies. The whole problem is not to be contained in a single formula. Life in its manifold versatility cannot be caught in the simple net of natural selection which the newer Darwinians have spread for it in vain.

The supreme fact, of which all theories seek to render some account, is the fact of direction in nature. We are concerned in this connection with theories of evolution so far as they may help us understand what the method of direction throughout nature has been. To some extent they do show the method, or how nature has led life along its upward way; viz., — with mechanical fidelity, with chemical assiduity, with ceaseless discrimination and selection, in a method which may perhaps best be described, broadly speaking, as the continuous adjustment and readjustment of inner and outward factors and conditions. But in natural science it always is, as it so often is with us in climbing a mountain; we gain one summit only to find another still higher to climb. By these biological theories we do not gain the last height of interpretation. We have confronting us the further and immense question: What is the highest meaning of evolution? What above all does this unmistakable fact of direction throughout the organic kingdom mean?

It belongs to the higher biology to search this prob-

[1] See Hertwig, *Biological Problems of To-day*, p. 136: *Die Zelle und die Gewebe*, B. ii. ss. 73, 271 *sq.*

lem. And the biologists themselves are at this point our best witnesses. As thoughtful observers they cannot rest satisfied with a merely mechanical explanation of the organic realm. The laws under which things move, are not the sovereign power in this or any kingdom. The modes of working are not the causes of the work done; as the mechanism of a locomotive is not the reason why it moves, and at certain rates, along a defined track, to a predetermined terminus. Something besides the locomotive is needed to explain both the locomotive and its motions. A description of the methods of nature's operations, however scientific, is not knowledge of the energy which moves through all things, and holds the universe to its course. None realize this more clearly than some of the most eminent biological investigators. Oscar Hertwig, for example, who is one of the most eminent students of cell-life, regards biology as a province in which mechanism in the strict sense of the physicist is in a very limited manner applicable; and in most cases the words mechanics and mechanism, when used in biology, he says, "have no real contents"; — they are words which conceal our ignorance.[1] "No one," he declares, "can tell through a physical-chemical analysis why at this place or that, under tension and pressure certain cells form a little beam of bone, why here cells secrete saliva-ferments, there have become adapted to the perception of light or sound or smell, or arranged together for an eye, or a labyrinth for hearing or smelling. We can, it is true, perceive and understand that everywhere these forma-

[1] *Zeit- und Streitfragen der Biologie*, Heft 2, ss. 18–19.

tions have relations to the nature which surrounds them, which physically and chemically can be recognized and understood as necessary; but the nature-process itself, which has brought them forth, the activity of the cells, which calls all these purposive formations into life, is to us as unintelligible as a process of feeling and thinking which plays itself out in the apparatus of our senses and nerves." [1]

We might cite similar expressions from eminent biological investigators, if only for the purpose of a warning against the superficially smart utterances of some students who will speak as though a century's science had reduced everything vital and intelligent to the dead level of a mechanical world; as though the wonder of the ages of progressive evolution, the living cell, were reduced to a simple mechanical contrivance like a steam-engine; — an engine of life indeed, which not only goes, but which lays its own track, starts itself, and stops when ready; which improves itself also as it goes along, and produces from itself other mechanisms even better than itself; for that is what the engine in an organic cell will do, give it time. Further citations of a similar tenor, however, may be rendered unnecessary if we add the following declaration of so pronounced an agnostic as Karl Pearson, which hits the biological mechanics fairly on the head: "Clearly those who say mechanism cannot *explain* life are perfectly correct, but then mechanism does not explain anything. Those, on the other hand, who say mechanism cannot *describe* life are going far

[1] *Die Zelle und die Gewebe*, B. ii. s. 258.

beyond what is justifiable in the present state of our knowledge."[1]

Turning again from the authorities to the facts — nature itself being always the final authority — several recently observed instances may be adduced which show the insufficiency of any merely mechanical theories of the living world. One is the conduct under different kinds of stimulation of minute unicellular animals, such as inhabit in considerable numbers a drop of water suitable for their swarming. It has been held by some writers that the movements of these simplest living things, when stimulated, are just like the movements which characterize inorganic substances under certain conditions; and hence by identifying similar motions among chemicals and among *Infusoria* it was supposed that a long step was taken toward that "analysis of vital processes into simple chemical and physical ones, which is deemed by many the final goal of biological science." But under closer examination this apparent similarity between some chemical motions and simple physiological movements has resolved itself into real differences. When the investigations were carried out more thoroughly, it was observed that unicellular organisms do not behave as chemical particles do. The organism is discovered to have its own peculiar way of reacting to stimulus. We know that it is so in the case of a man who has taken a drop too much: and we know now also that organic reactions to stimulation begin with the very cells, and in their own peculiar, and not merely chemical way. For thorough investiga-

[1] *Grammar of Science*, p. 344.

tion has shown that the reaction of these animalcules is distinctly physiological, and not merely physical; organic, and not purely chemical. If one of these unicellular bodies meets with anything that acts as a stimulus upon it, it will respond uniformly according to its own nature first by swimming backwards, then by swimming always towards the same side, and then by swimming forward again. Only, in some cases, when it is strongly stimulated directly from behind, it will respond according to its infinitesimal degree of intelligence, shall we say? by swimming straight ahead somewhat faster.[1] Now these motions are not purely physical ones, like that of particles of steel drawn towards a magnet. They do not resemble the manner of any known chemical reactions. They have their own character. Life in its first cells has its proper organic responses to make. Internal factors are operative in simplest organic reactions. "The organism," we are told by the observer, "reacts as an individual, not as a substance." [2]

A different instance, which discloses the same principle of organic rather than mechanical response, is furnished by Professor Wilson. We shall have to be somewhat technical in the description of it, but as it is one of those small things in nature easily escaping observation, which mean very much, we may take some pains to understand it. When cells divide and multiply, the spindles in them sometimes arrange themselves some-

[1] Jennings, H. S., "Behaviour of Unicellular Organisms," *Wood's Holl, Biol. Lects.* 1899, pp. 93 *sq.*

[2] *Ibid.* p. 111.

what in the form of a spiral; this is spoken of in the books as spiral cleavage. Now there is a well known mechanical principle, which would cause these dividing cells to be arranged one after another with the least possible contact of their surfaces, very much as a succession of soap bubbles will just touch each other. To some extent this mechanical principle has been observed among multiplying cells. But in some instances of spiral cleavage this mechanical order of arrangement becomes subordinated to some quite different principle. Thus in the development of annelids and mollusks, where at first the cells are divided and multiplied in a spiral, that arrangement shortly is changed for a very different form; it gives way, says Professor Wilson, "more or less completely to a bilateral type of division in which the rule of minimum surface contact is often violated." That is, we see in such instances a mechanical law by some means suspended in the development of the egg, and some other principle intervenes and becomes controlling. Or, to continue quoting Professor Wilson: "We see here a tendency operating directly against, and finally overcoming, the mechanical factor which predominates in the earlier stages; and in some cases, *e. g.* in the egg of *Clavelina* and other tunicates, this tendency predominates from the beginning."[1] Another American biologist has called attention to a curious fact of behavior within the egg of a fresh-water bivalve, which presents a similar puzzle to a purely mechanical theory of vital movements. Studying with minutest particularity the division of cells and

[1] *Opus cit.* p. 369.

the growth of the body in this specimen, he noticed that the nucleus of the egg wandered through the cytoplasm (the substance of the egg) from one side to the other, from the front to the back, stopping at various stations, and giving off a cell at each one. Finally the nucleus stopped at the centre of the cell, and a perfectly bilateral spindle was formed. "Why," he asks, "does it stop there? Is it because its environment has changed? If so, the change is such as to elude the closest scrutiny." His answer to this puzzle of apparently definite, constructive movement within the cell is this: "In fact the cell is a builder which lays one stone here, another there, each of which is placed with reference to future development."[1]

In connection with these facts one general observation may be added. When we overtake natural selection in its operation, we do not then come upon the fact of direction for the first time within our knowledge. Direction is prior in nature to selection. Natural selection marks a second, not the first point where science may lay hold of nature. For the fact of some determination of things exists before the fact of any selection between them. Before ever natural selection could begin to work, some fixed points had to be gained from which it might work. Selection lies in nature between units at least of living matter which already are determinate. Before the fitness of an organism to survive can be tested, there must be given its capacity to live at all. A flowing stream makes no selection among the

[1] Lillie, F. R., "The Embryology of the Unionidæ," *Journal of Morphology*, x, 1895, p. 46.

breaking bubbles on its surface. Specific forms in the organic realm must appear and be held firm long enough to afford a basis for favorable variations. Variation is from something already formed to something better or perhaps worse formed. The biological problem goes deeper than a guess at the possible causes of variations. How has it come to pass that organic forms have been held firm and true long enough to acquire an adaptive variation? Some conserving force, some fixing agency, so to speak, must be presupposed to account for the stability of the primal cell, for the definite number of chromosomes, as well as for the structural relations of the different parts of an organic growth; and some determining factor must be assumed at the start, whatever we may suppose its nature to have been. We cannot, in a word, have anywhere a definitely moulded form without some moulding, whether there appears a moulding hand or not. Nature's first problem is not merely a problem of forces; it is a problem of forms; fitness among these may be her next problem, the question of her advance; and selection doubtless has had an important *rôle* to play in explaining the preservation of fit forms; but it cannot explain either the forms or their fitness. In other words, even if evolution may explain everything else, it cannot explain itself.

We pause a moment at this point to determine just how far in our inquiry into the problem of direction in nature we have thus far gone. We began by observing various phenomena which show the fact of some direction in the evolution of the worlds. We learn what we may concerning the mechanism by means of which life runs along its advancing way. We have glanced at prevalent scientific theories for some account of the mode of the development of life; and we may gain partially true conceptions of the working methods of evolution. But we have further seen that no scientific theory of the course of nature affords any rational explanation of it. Why nature has been so ordered, what power works through its continuous processes, how its end is predetermined, — this is not contained in any formula for evolution which science has to offer. The fact of direction we know; the mechanism and mode of it to some extent we think that we know; but the significance of it, and the real interpretation of it, — that is another question. Yet it is the question put directly to our human reason by the facts observed. For the beginnings of this process of development our biologists have to look farther than they can peer through their microscopes; for the energy which carries it on they have to seek beyond their mathematical equations of its workings; for the continuity and constancy of its course, for the unity underlying it all, they have to venture out into the presence of some power which cannot be subjected to their experiments. The profounder our knowledge of the process of nature the greater becomes the demand for our understanding of it of some draft upon the unseen and the eternal. Evolutionary philosophy must honor that draft.

Before advancing to the argument, which may be drawn from the great nature-process, we would recall summarily the facts which we have successively observed, that we may realize the momentum of them in their totality. First in our inquiry we met the fact of direction in inorganic evolution. That reached its end, and passed its energy up into the organic kingdom. Next we met at the beginning of the organic evolution the organized cell; this organic unit, where our science can first lay hold of it, is known to be something already definitely formed. It is a structure fitted for its function. The cell is something called and chosen for its specific task. Then we saw how nature proceeded to use these living cells in the development of the plant and animal world; as a happy thought in nature the principle of division of labor and mutual service was taken up and has been followed out through associations, colonies, and mutually adapted organs, to the perfection of the body in the higher animals and man. Then turning back again to the cell, searching anew for the secret of this direction and movement of life towards the perfection of organization, we observed the intricate process of its division and multiplication; — which process, if it did not follow a purpose, certainly came to some choice results. We perceived the remarkable provision which exists for the equal division of paternal and maternal elements, and for the exact specific development of each egg. Then we were surprised by the appearance of still further significant facts in the life-history of the cells; such as the fact of the phenomena of the timing together and mutual adaptation of the parts and processes of the development of the embryo, and the subordination also of individual cells to the use of the whole organism. We gained thus a new point of view from consideration of the organism standpoint, or the control of the individual parts by the organism as a whole. Furthermore all these elements and problems of direction in nature which are striking enough in the original egg-cell, are multiplied, diversified, gathered into one stupendous fact of organic direction in the ascent of life, as it reaches its latest and highest achievements of power, beauty, and harmony, of instinct, self-conscious thought, and love. In the simplest statement of the facts we have presented to us something which seems to transcend a merely mathematical and mechanical problem, and which looks very much on the face of it like an intellectual achievement.

CHAPTER V

INTELLIGENT CHARACTER OF DIRECTION IN NATURE

The question which now fairly confronts us, and which no thoughtful observer of nature would wish to evade, is this: What is the character of the supreme fact of direction in nature?

In entering upon this further inquiry we should recall the principles of natural revelation which were discussed in the second chapter. We shall need to apply them from this point on repeatedly in our further study of evolution.

We have observed that nature's revelation comes from within, shining out of her own processes, and with increasing self-luminousness as the evolution grows. We shall accordingly seek to discern the signs of character in nature which appear with the development of life, and perceive how they become more clear and are more impressive as the revelation through evolution grows.

We point first to the sign of Orderliness.

As our previous survey of the facts has shown, this sign is written everywhere in the history of life. It is a general intellectual mark upon nature as a whole. It does not fail, it is not blurred in the least, when we read it microscopically. It is an intellectual mark etched upon the minutest structure, and to be noticed in the earliest functional responses of the organic world. It is a sign of some good ordering; for in nature, as in a household, orderliness is a characteristic of good housekeeping; and it is something to be recognized and understood over and above the furnishings of the house, which may render possible some orderly housekeeping. The furniture is the means, the servants are the agents, but not in them lies the reason of the household's order. Nature shows in every room, from basement to upper chamber, and even in its most secret closets, clean, economic, and orderly housekeeping. The fact of orderliness is a royal sign, which the triumphs of the sciences of the nineteenth century hand over to the philosophy of our time to read and to understand.

Let us suppose that so many pins, for example, are found in a paper arranged in rows. The fact that they are of uniform size renders it mechanically possible to put them up in orderly rows; but it does not explain the fact that they are so put together in exact rows. The orderliness of their arrangement is a characteristic of a paper of pins in addition to their properties as pins which have equal lengths, and each of them a definite point and a head of the same size as the others. We are not reasoning merely from the fact, which Maxwell observed, that the atoms, like so many pins, have every appearance of being manufactured articles. Grant that evolution may have been the method of their manufacture. We are noticing the additional fact of their orderly arrangement. The protoplasmic order, as it has been called, is an arrangement of molecules and a disposition of energies which is to be considered as something over and above the properties of matter which render possible such arrangements and dispositions of it in organic structures for vital uses.

Nor is this all. The illustration from a single paper of similar pins is not sufficient. We have to do in nature not with order of one kind only, but with several kinds of order. We should compare it not to one paper of pins of the same size, but to a whole work-basket, all arranged in good order. Nature is not a slovenly work-basket. We may enumerate several distinct orders, which are all put up together, as it were, in nature's one orderliness.

1. The physical order. In it are given the atoms and their geometric relations together with the energy represented by them. This is the original elementary order; each element is an appearance of molecules of the same kind.

2. The chemical order. The atoms are capable of forming combinations more or less stable with one another. Their relations and mutual behavior yield the laws of chemistry.

3. The protoplasmic order. We find certain highly complex molecules, as it is supposed, combining and acting together in a new way which is called vital. The movements of a bit of protoplasm reveal the new order of life.

4. Still further, the order of development, or the phylogenetic order. This is included partly in the previous order, yet it presents phenomena which so far transcend the initial protoplasmic order that it may be

classified by itself. It is the order of the development and differentiation of living matter in the succession of organic forms. It discloses as its distinctive characteristics, besides the initial properties of protoplasm, such phenomena as variation and heredity, adaptation and selection, and the subordination of the individual cells to the organism as a whole, and its functions.

5. Coming to revelation through the latter orders with increasing self-evidence is a still higher, the sentient order, the order of animal intelligence. Life feels itself. It becomes more or less conscious life.

6. Above this and crowning the preceding orders, rooted and grounded in all below, yet transcending all, is the order of rational life, — life interpretative of itself. Beyond the life feeling itself is the life reasoning about itself; personal life is the order of self-interpretative life; not merely self-conscious, but self-interpretative life.

Such are the several orders, each having its own quality, each of its own distinctive kind, which nevertheless are all bound together in nature's one orderly process. Now our immediate point is, that orderliness, comprehending as it does so much ordering, and of so many successions and kinds of things, is a great mark of character, a sign written large on nature for us to read and to be guided by. We must take in the whole series of orders in nature, and consider their significance together as one well-ordered whole, if we would interpret aright the facts of direction in the process of nature.[1]

[1] See J. Morris, *A New Natural Theology*, for an able critical presentation of the theistic argument from the several orders of evolution.

It is impossible for an open-eyed philosophy, it is not possible for a science which is not color-blind, to run heedlessly by this sign of orderliness which is held aloft over the track of evolution. It is flung out as a sign to be heeded by any good philosophic engineer, and to pass it by may lead a system of biology to speedy destruction.

Moreover, the significance of orderliness in evolution is multiplied and emphasized by the repetition of this characteristic in each new, successive advance of evolution. If it is not a sign of some purpose, then we must suppose that after the fortuitous meeting of atoms in the primal molecules must have followed fortuitously the concourse of the molecules in a hydrocarbonate, a proteid, an amœba; and still further that these must have fortuitously grown into the combinations of the body of an ascidian, a mammal, or a man. But with the rise of successive orders the possibility of their coming fortuitously to be, is decreased numerically by an indefinite power of the known quantities in nature's equation. The argument against a chance happening of orderliness increases towards the infinite with the advent of the most highly organized forms of life; it breaks down utterly before the supreme fact of the one harmonized evolution of all the orders of nature.

Suppose that from an indefinite number of ink spots twenty-six letters of an alphabet had in the course of time accidentally occurred. Grant that to be conceivable, although it may require a lively scientific imagination to conceive of its possibility. We naturally might feel concerning those formed letters of the alphabet as Clerk Maxwell thought with regard to the atoms, that they have every appearance of manufactured articles. Nevertheless, waiving the initial difficulty as to the formation of the original letters, imagine them to be fortuitous products, without sign of intelligence upon them. But this would be only the beginning of difficulties. This were only the first shock to our power of imagination. We come across on nature's first page an arrangement of several letters in a word — a monosyllable it may be — yet a word to which definite meaning belongs. The arrangement of the letters in the formed word is a new fact to be explained. We find this elementary word turning up here and there and everywhere in the course of nature: and wherever it occurs, it is always spelled in the same way. Its letters — those chromosomes in the cell — are always the same in each specific word of life. But this is only the first surprise. In the opening sentences of the book of life we read other words, formed of similar letters, longer than monosyllables and more complex; and they, likewise, are always spelled truly, in the same definite way, each with its proper number of letters and syllables, of chromosomes and cells. We have before us the mystery of many and regularly recurring words. And this opens up a further wonder. We turn the pages and perceive that these words of life are not single and detached: behold! they arrange themselves in certain relations to each other for which they seem to be fitted. We discover upon closer inspection that they are mutually adapted for such arrangement, and that when they have so fallen together, a new order appears — a sentence is composed. And still further, sentence follows sentence, each orderly and complete in itself, and all having apparently some connection with one another. For with the single sentence, having its specific significance, the wonder does not end. The separate sentences fall into groups. We mark the division and succession of paragraphs on nature's page. One leads up to the next. Each part takes meaning from the preceding, and carries it on to the following pages. We find that we can understand no sentence aright, if we read it out of its connection. Still the wonder grows; for these larger paragraphs seem to belong to some great argument, which runs through all the sentences and words, and to constitute even beyond our understanding some vast system of thought. Our knowledge may end with the paragraphs and chapters which nature thus far has published; we have by no means as yet read to the end the whole history of the creation; we have begun to know, we have not yet learned all of the poem of the divine ideas, as Saint Augustine finely called the creation. We have not yet lived through to the end of Nature's great argument and epic of divinity. But though we know in part, we know; though we have mastered but a few paragraphs, they have intelligible, although it be still broken meanings to us. And the meanings we have spelled out and put together, are enough to show that they all, with the things not yet clearly understood, belong together to one book of life: these parts which we know, have their place and time and meaning in the one order of intelligence which is vaster than we know.[1]

[1] So Brooks argues that mechanism does not touch the question as to why nature is orderly. The opposite of order is not freedom but the

A similar but distinct sign of nature to be interpreted is the sign of fitness.

The quality of fitness, however it may have originated, is a mark of character in nature; that is, it signifies something. Notice especially that in the mutual fitness of organic forms we have to do not merely with a symmetrical arrangement of molecules as in a crystal; there is presented to us for our rational interpretation of it the striking fact that in an organism certain parts are fitted and timed to each other for mutual use and the benefit of the organism as a whole, which taken together they compose. The fitness is a characteristic of the organism as a whole, and it is for the service of the organism as one living thing. There is given in it the new fact in nature of the adaptation of one part to another for some further use. Take as an instance a union of living cells, like the *hydra*, where, as we have already noticed, the social principle of the division of labor makes one of its earliest appearances in nature's economy. It is a combination of cells, which are still so independent that if a hydra be cut in two, either half may grow into a complete hydra. Indeed in some recent experiments a whole hydra has been grown from a single tentacle. But these cells have begun to act in concert, and to assume specific functions, becoming helpful to each other in a common life, forming

disorderly; order is not necessity, *i. e.*, as opposed to free intelligence. See *Foundations of Zoology*. This remark from a naturalist is worth quoting, "Order is not an explanation of anything, but something that itself calls for explanation." *Ibid.* p. 287. See also Romanes: "Physical causation cannot be made to supply its own explanation." *Thoughts on Religion*, pp. 70–75.

"a single multicellular unit."[1] We may recall without repeating the facts, how this vital principle of fitting parts together for mutual service has grown and been strengthened, and diversified, and how it has in time brought forth fruits of life of the richest value. It is an idea which thus grows and bears the fruit of life. It is the intelligible principle of organization for use. It is the moral idea of mutual service. If nature's first thought is order, her second thought is mutual service.

This sign likewise — let us emphasize it — is something to be interpreted by us over and above the physical properties of life, or any mechanical methods of it, through which this increasing fitness may have been secured. It is a quality of evolution apart from its mechanics. The question for biological philosophy is not merely, how has it been wrought, but what does it mean? And its significance becomes more commanding as this sign of fitness is held aloft, and borne to the front in the battle and the triumph of life. It is one of nature's royal banners to be displayed because of the truth.

A third, and most important characteristic of the principle of natural direction is the sign of increasing vital value.

This mark of evolution has not thus far been clearly enough recognized by biological science. It may be definitely formulated as the law of increase of vital value in evolution. It will be found to be a sign possessing great interpretative suggestiveness.

[1] Parker, *ibid.* p. 230.

We cannot apply directly any scale of values to the inorganic world; but in the organic realm we may easily distinguish between the worths of different elements or forms. We can measure the values of different salts to vegetables, or the worths of cereals and fruits, of flowers and precious stones, to animals or to man's enjoyment and use; but we cannot predicate of inorganic things distinctive values in themselves apart from their utility to existences which are above them. It is only in relation to something higher that dead things acquire value. With the introduction of life there is brought in also the new element of worth. The kingdom of life is a kingdom of worths. Even in its first protoplasmic movements life is something which assumes its own value; it is worth its effort to preserve itself. Worth in a word comes in with life. Everywhere the idea of worth accompanies the fact of life. Moreover, we may construct from vital manifestation a very excellent standard of value — a well graduated scale — by means of which we may distinguish between higher and lower vital worths. We may measure vital values with reference to two characteristics of the organic kingdom, — capacity for living, and pleasure in living. By the amount of capacity for life and of joy in life, the vital worth of an organism may be measured, or a comparative estimate be made of the place on the scale of life of different animals. An animal like a dog possessed of a complex body which is capable of many motions, and consequent variety of sensations, stands higher on the scale of vital value than the oyster; as in turn a clam with its distinct nervous and muscular system is more highly organized and is capable of more responsive existence to its surroundings, as the tide comes in, than is an amœba which at best can only throw its temporary arms around a passing diatom. Vital value, then, is a natural sign; and advance in vital value may offer a further clue to the character of the direction which has been actually followed in the development of life. This sign may become one of fine significance in helping us determine the moral character of natural development.

A fourth characteristic of direction in nature is the sign of limitation.

The directive principle works within limits in the development of life. Hence the character of the evolution is to be estimated with reference to the limitations which are given in its sphere of action. The directing Power in nature cannot be judged as an unlimited Omnipotence.

We do not see the action of unlimited Omnipotence within any limited creation. But in our interpretation of the higher meaning of nature this law of limitation is too often overlooked; it will be well therefore for us to dwell upon this sign of limitation in evolution.

We observe that there is a limit fixed by the connection of the order of life with the lower order of inorganic matter. The organism is in many ways still dependent upon the inorganic — living matter upon dead matter. The higher feeds upon the lower. The lower is always bound closely enough to the higher to be its servant. This mutual dependence forms an unavoidable limitation under any conceivable directive Power in the evolution of the organic realm. Such directive energy may transcend, but it cannot break loose from its relation to the inorganic world. Life in the drawing-room indeed has gone beyond life in the kitchen; but if the freer life of the parlor should break its natural continuity and declare its utter freedom from the serving life in the kitchen, it would itself soon miserably perish. Christian Science, so-called, may attempt to do that; — to live happily in a thoughtful upper chamber without respect to the work to be done in the basement, and its daily dependence upon it; it may attempt to cut mind loose from the limitations of the material; but Omnipotence in nature has not attempted to do that. It is a biological truism that the plant cannot grow except from its roots, the eagle cannot soar out of the air in which it spreads its wings; and thought, likewise, cannot remain in this bodily organism without dependence upon the changes which attend its free motions in the cells of the brain. Mind may hereafter enter into different and better relations to the physical order in some embodiment beyond our possible present; but here and now mind finds some limits in its existing relation to matter. It is not science to ignore them; neither is it ever Christian not to be scientific. It is the plain fact of our life that the highest which we know is still bound to the lowest which we can see; we belong to nature, although we are born to master it.

Secondly, a limit to directive energy is fixed in the properties of the vital matter within the cell. Physical and chemical properties, even when combined in the quickly changeable, unstable proteids for the play of life, are still limited properties and energies. Life in the protoplasmic field offers to a directive Intelligence large and noble opportunity, but nevertheless it is a restricted field of action. If Omnipotence chooses to work within the confines of a living cell, there are some things which omnipotence cannot do within that limited sphere. It may develop, but it cannot at the same time spoil the cell. Omnipotence has been truly defined, not as the power to do everything, but as the power to do everything that can be done. It does not attempt the impossible either in a microscopic cell, or in the world around us, or in the heavens above.

Thirdly, there is a limit fixed in the relation of organic forms among themselves. The organic world is one realm, and all its species exist in relations to each other. A very interesting scientific chapter concerning this mutual dependence of all things living may be read by those who care to familiarize themselves with the services of many kinds which insects perform both in the vegetable and animal economy. Probably not a single family of insects could be exterminated without consequences more far-reaching than we might foresee. Millions of dollars have been lost because of the visitation of some insect tribe to men's fields and orchards; large investments have been saved because some other insect, before unknown, has been imported to rescue from devastation the orchards and the grain fields. And our obligations to the insects for the wealth and beauty of our world is beyond all estimate. The natural laws of selection, survival, extermination, adaptive variations, are expressions of this general interdependence of living things from which nothing can escape. But this organic mutuality acts also as a limitation upon any directive Power in living nature. It cannot do violence to the unity of life. It cannot keep life moving on, and at the same time break its continuity. It cannot spin and break life's thread at the same time. Otherwise it would not be a principle of order. It would come to destroy, and not to fulfil.

Having thus far observed first the evidence of the fact of direction, and then having marked several signs of its character; viz., the sign of orderliness, of fitness, of increasing vital value, and also of limitation; we are now prepared for some conclusions concerning the character of direction in nature. Certain inferences as to its ultimate quality may be drawn from the facts which have been adduced.

We infer that the directive principle throughout nature has intelligence.

These signs, which we have discovered, we recognize as characteristics of intelligent action. Such marks have in nature the appearance of mental traits. The directive energy throughout evolution acts like an intelligent influence in correlation with its several orders. Intelligence in nature, it is true, cannot be quantitatively measured, yet it may be effectively present, and its presence become manifest to our intelligence. The only cause for not accepting at once this evidence of intelligence in natural direction arises from the difficulty of conceiving scientifically the method of its action — it is a difficulty, that is, of the imagination rather than of reason. How, it will be asked, can an energy act within a natural order, and be recognized, when it escapes any quantitative measurement in the laboratory? Stick to quantities, says a mathematical friend, and you will be right. Yes, but quantities have some immeasurable qualities — even the x in his equation has the quality of being an unknown quantity; and the nth power has the quality of the indefinite or the mathematical infinite. Nature possesses quality throughout. Evolution has the qualitative signs which we have been reviewing; and they must mean something. They seem to imply intelligent action. How is that possible? Well, the relation between our thought and our body is nature's answer, at our present stage of evolution, that it is possible: and it is answer enough, if we will not obscure it. Energies so different as mind and matter, as directive power and mechanical forces, can because they do work together. Deny mind working directively within yourself, and you may also deny mind working directively in the cells. But in such denial you have left no rational explanation either of the free play of your own mind, or of the mechanical processes of the living cell. Mind and matter are to us irreducible to a common term; but in experience the one accompanies and acts upon the course of the lower factor, and the lower limits the power of the higher. We find in mind a true cause, that is, an actual directive force over the nerve centres, with which it is vitally related. Now we hold that we may discover, and that the signs of nature indicate that there is a similar action and reaction between all living matter and some Intelligence. Though the mental factor in evolution cannot be rendered visible, or weighed and verified in chemical proportions and reactions, it exists, and many residual phenomena show that it exists, in some influential relation to the whole organic process of the world. Mind in some way is a determining factor of evolution. Mind has been persistent in its influence through the entire course of nature. We know that it works as directive energy in us; but we are products of evolution; we cannot deny therefore that it has worked before us; — if it can guide us, it can have been a directive energy in the simplest cell, and throughout the whole nature-process from which we come. Within the limits of its properties the organic realm as a whole is open to directive Intelligence.

Such directive action of a superior Intelligence may be conceived of as occurring either continuously, or at certain selected and specialized points, or in both these modes; in neither case would it be necessarily a contradiction, or a suspension, of the mechanical law of the conservation of energy. It may witness only to a limitation of that law; and the limitation of it may lie either in the scope of its action, or in our power to measure its range. It may be that in mental energy throughout evolution, and in its physical correlations, we are to recognize simply a form of energy which we are incompetent to determine with any measuring-rod now within the hand of our science. A gap in our knowledge may lie here, but no real break in nature's continuity between the spiritual and the material. Who can follow the radiant energy of the sun through all its relations in the luminiferous ether of space, and declare what its ultimate transformations may be, so that nothing shall be wasted, and not a stray sunbeam lost? Who then can trace the more ethereal course of thought through the universe, and discern the utmost possibilities of its radiant energy? Indeed a puzzled astronomer, in a recent article, raises the question whether there may not be some unknown form of energy connected with the nebulæ to account for their intense radiance.[1] We know too little even of the physical energies of the universe to warrant us in excluding the possible action and play of the force of directive Intelligence in nature. So Mr. Ward has argued with good reason: "Not only are the several forms of energy qualitatively distinct, but we have, I take it, no means of knowing that all these forms have been ascertained. . . . But it is obvious that this possibility of unknown forms of energy, coupled with the probability that the known forms are not all mechanical, suggests many new vistas, for which it behooves us to keep an open mind."[2]

The real question is not one of possibility, but of fact. We have already found in the facts reasons which compel belief in "the unknown factor of evolution." We go a step further in the affirmation that this unknown factor, the working of which the phenomena of life lead us to assume, remains unknown only as we seek to discover its nature among the physical and chemical properties of living matter; but

1 S. Newcomb, *Pop. Science Month.* lviii. p. 149.

2 *Naturalism and Agnosticism*, vol. i. p. 168.

that it makes itself known as present and influential amid these properties, the moment we behold them in the light of our mental life. In other words, our knowledge of the order of intelligence in which we live, sheds an interpretative light down through the lower orders to the very foundations on which our dwelling has been built. It is true knowledge, whenever we can read that which is lower in nature by the light of that which is higher. The mental fulfilments interpret the animal beginnings.

In our effort thus to interpret nature in the new light of evolutionary science the difficulty of the imagination will often be brought back to us, How can these things be? It is the old difficulty in the spiritual conception of the world which a master of the wisdom of his day expressed to the great Teacher, as they were talking by night together alone upon the housetop under the stars, — How can it be?

The conceptual difficulty immediately before us at this present point of our argument relates to the correlation and co-working of intelligence and the mechanism of nature. Both exist; the facts show mechanism, and the facts indicate also something that looks like intelligent action; the nature-process, as Oscar Hertwig puts it, resembling a process of thought.[1] We may go so far as to say that the same facts and the same evidence which disclose mechanism in nature, indicate also the intelligent operation of that mechanism.

Life is not merely a process, it is progress; evolution is not only development, it is progressive development;

[1] *Die Zelle und die Gewebe*, p. 258.

its advance may be marked and measured on the scale of vital values. The application of this scale of vital values to evolution gives an unmistakable reading; it is sufficient answer to those who hold that evolution is a process without progress. But how is an intelligent natural process to be conceived?

As a needed aid to the imagination some suppositions may be suggested which may help us in the effort rationally to conceive how such intelligent direction may act throughout the course of nature. We may refer for this purpose to an ingenious hypothesis which some speculative trouble with the laws of heat led the great physicist, Clerk Maxwell, to put forth, and which has become known as Maxwell's hypothesis of the sorting demon. He supposed that a vessel was made having two compartments, separated by a partition, through a hole in which particles of matter could pass from one part of the vessel to the other. Then he conceived an intelligence presiding over it, who could perceive the darting molecules, as they came streaming towards the partition, and by deftly opening and shutting the hole he could sift all the molecules of the same kind into one compartment. Thus he imagined that through the agency of this sorting demon, molecules of differing velocities might be separated within the two compartments, and without any expenditure or loss of molecular energy. So without any breach of the law of the conservation of energy, matter might be intelligently arranged and determined. The direction of those molecules which entered the hole would not have been deflected, they would not even have been touched; but nevertheless they would have been selected.[1]

This clever conception is good for its purpose; but it would be carrying it too far to say that no energy is expended in this assortment of the molecules. The sorting demon in his own motions performs work, although he does not touch the molecules. His work might not be seen by an intelligent observer, if we suppose him to be located within the cover. He would perceive only the regular streaming in of the atoms, and might be an agnostic as to any arranging Intelligence outside his little box. He might, however, if he had a good mind, infer from the regularity of the molecules coming in through the hole in the cover that somehow, by some sifting agency, they had been assorted before he had knowledge of them. An intelligence within the box might say: "It is true I know in part, but what I know, I know; and one thing I know is that by some agency or energy at work among the molecules they come regularly into my world."

Direction, we are thus imagining with Maxwell, may be conceived to be given to matter, although it may not be measurable as a quantity from our side of things. In our own life there is certainly action and reaction between intelligence and the cells of the bodily organism. And as matter of fact nature throughout its age-long process seems to have been very intelligently sifted.[2]

[1] Maxwell, *Theory of Heat*, ed. 1894, pp. 358 *sq.* His object was to illustrate a limitation in the second law of thermodynamics.

[2] See Ward, *opus cit.* i. pp. 201 *sq.*

Another aid to the scientific imagination in conceiving the mode in which intelligence may act as a directive principle without measurable expenditure of work, may be obtained if we carry out in a somewhat similar way a suggestion of the physiologist Verworn concerning the action of stimuli on organisms. He remarks: "It is necessary to the occurrence of the phenomena in question (stimulation) that differences in stimulation exist in different parts of the body. If stimuli act equally upon all sides, all the effects of stimulation described in the preceding section occur, but a directive effect is necessarily absent. Only unsymmetrical stimulation can control the direction of motion."[1] Think a moment of that. Unsymmetrical stimulation, it appears, may control the direction of motion. If then an intelligence like Maxwell's sorting demon, could contrive merely to alter the position of different stimuli, to sort out some stimuli and to gather others together, he would according to this physiologist exert a directive effect upon the development of life. If he could so select and utilize stimuli in the course of the world without being detected, he would act as an unseen providence in the guidance of life. An exterior Power can readily be conceived so to act without observation by us, at least, in its work. If known, it must become known through its effects. The unknown Factor in evolution, that is, will be revealed gradually, progressively, more and more evidently through the character of its stimulation in nature and history.

[1] *Gen. Phys.* s. 429.

CHAPTER VI

MORAL CHARACTER OF DIRECTION IN NATURE

ASSUMING that evolution indicates intelligence, the further question at once arises, Is its direction also moral? From the character of intelligence a direct presumption arises that it must also be moral; for reason and right within our experience of them seem to be vitally related. Given anywhere the rational, we may assume from human experience the existence likewise in some degree of the moral. At least reason has natural moral ability enough to discern some distinction between right and wrong. But besides this general presumption that a rationally intelligible universe must possess also some moral character, do the facts of direction which may actually be observed, show indication of any moral guidance also in nature?

This is the old question — older than the book of Job — of moral providence in the world. We are to look into it again in the new light, which falls upon all man's problems, from the nineteenth century's science.

If there is benevolent character in evolution, it will naturally reveal itself in a steady enhancement of vital values. We should search for indications of it in life's increasing worth. Whatever increases vital values has benevolent character. But is there secured through evolution any such gain in the worth of life? Our problem — the old, but ever new question of benevolence in nature — puts itself therefore scientifically after this manner: Judged by the tests of vital values, viz., capacity for life and increase of happiness, does evolution show good moral character?

Now the one broad fact open to all eyes is that life in the age-long course of its development has gained capacity for higher exercise and richer happiness. Nature at first lives and stirs, it does not play or sing. Nature erelong begins to play and breaks forth into song.

Mark this ascent of life on the scale of sensitiveness, and the moral significance of this advance. We are very near the minimum of sensitiveness when we watch the organic responses of the *Infusoria.* The simple reflex motion of an animalcule to a stimulus represents a degree of sensitiveness just above the zero-mark. For we may speak of a zero-mark of psychic life immediately below which there may be chemical reaction, and just above which organic sensitiveness may occur; and, rising from that point, is the whole ascending series of the degrees and kinds of psychic life. Now if life reaching up towards its more intelligent manifestations had been stopped short just above this psychic zero-point; if the simple reflex motion of the free swimming *Infusoria* had marked its highest attainment in this respect; certainly it would have disclosed at that broken point little evidence so far as we can see of any vital worth in happiness. The infinitesimal life of a drop of water shows free motions, organic responses, and some effort at self-maintenance, but it has occurred to no observer of it to regard it as a joyous existence. Yet in this freer though infinitesimal world is opened the possibility of future joyousness, and some prophetic hint too of its coming. For let sensitiveness, once gained, increase; let it become fully developed, and in time animal pleasure in existence shall be the issue of it. Follow the long process of the development of sensation through, and you shall see this first glimmer of pleasurable existence grow as a beam in the darkness. Life far away began to gain capacity for freer outward play and for finer internal harmony. It put forth its tentacles toward some happier air, and felt after the glow of the sunshine. In its earlier metazoan stages the gain may seem but slight in the power of pleasurable sensation. A colony of cells, bound in some mutuality of service, seems to be only a working colony toiling in their humble way together for existence, but with little or no sensation of life as sweet and good. Nevertheless, even there the kingdom of animal pleasure is near at hand, and it is to come. Elementary life is dull and silent; but something would be lost, something begun worth the finishing would disappear, should its effort at self-maintenance and up-building cease; if life, after its first brief flickering, should sink back into the inorganic. A good beginning at least of something possible and well worth gaining, would be hopelessly lost, should this early metazoan life disappear wholly into the darkness from whence it came. Those cells, as arranged in that simple connection, do not yet spell happiness; but they contain hint that something has been begun which may yet grow into joyous existence. The sensory satisfaction of a well fed worm or an oyster may not mean much; but it is a new vital fact, and it means something. Growing sentiency, as evolution keeps on, claims attention. It becomes in time a predominant factor, and is a clear sign that something good is surely coming through it to revelation. The mystery of life, as it shall disclose itself, may prove one of goodness. An observer, conceived to be standing at some point far away, where life had just come to evident feeling of itself, might not have discerned sign enough of moral character in it to make him believe; but he might have seen enough to cause him to cease to be an unbeliever, — to lead him to wonder and to wait for something better still to be revealed.

Follow in imagination this process of development on and on, until life on the earth becomes aglow with sensation, and in ever-varied forms is capable of harmonious adaptations and the satisfied appetencies of the animal world as we now know it. Measure the vital value of it at its height, when at last it has broken forth into supernal joy and gladness in our human consciousness of life as something nobly to be won, and grandly worth the living. An immeasurable distance has been traversed along this way marked by the sign of vital worth. A vast gain has been made in pleasurable capacity. The happiness possible to a man, as compared with the happiness possible to a monad, is high as the heavens above the earth. But the traversing this vast distance and the gain of this high power constitute a revelation; hereby is made manifest the moral character of the evolution. The end reached is a good end. Naturalism, therefore, as judged by the ages of accumulated contributions to sensitive capacity for happy life has worked well; naturalism, when seen thus in the large, takes on moral character; the order on the whole is a worthy order.

Thus far our argument has kept entirely on the sunny side of the way of life, and has passed the evil unnoticed by. But all through nature does not the dark side run parallel with the sunny side? With increase of sentiency and growing capacity for joy, do we not have given also increase of suffering and greater power of evil? Is not the poet strictly scientific when he sings,

> "Chords that vibrate sweetest pleasure,
> Thrill the deepest notes of woe."

It may not be denied that with enhanced capacity for pleasure there is opened greater liability to pain. We can suffer most through our friendships. Love holds within itself all the sorrows of the cross. Death has always shadowed life; and the shadow of it is deepest over the brightest life. Man who can live most, finds it hardest to die.

To such questioning of the moral intent of the world, as some good intention seems revealed through increasing sentiency, two answers are directly presented by the observed facts.

The pleasure and the pain do not, as matter of fact, increase in equal proportion, but the sum of pleasurable feeling over painful sensation represents a gain of life on the whole. The living capacity increases faster than the dying pain. Comparing any later stage of the development of life with earlier stages of it, the gain is always on the side of happy sentiency. The tree of life bears its fairest blossoms at the top. The singing birds build their nests among the upper branches. Wider vistas of joy open ever as life ascends. Looking at the matter with close scientific scrutiny, we perceive that increase of specialization in nature introduces an overplus of pleasurable sensation. The unorganized world is not the happiest world. Highly specialized life takes more pleasure in existence than can possibly enter and pervade a mere colony of cells. The pleasures which are rendered possible through the development of each special sense, vastly exceed the accompanying amount of possible painful sensation. Who of us would give up a good ear for music on account of the discords which at times one must hear, and forget? The seeing eye, itself become sunny in the sunshine, beholds much more on the earth in which it may take delight than in which it may perceive suffering. Each new increase in the power of the senses reveals a world of finer harmonies and fairer visions. The light in which the finished eye sees life, is vaster than all the shadows. Though death reigns, the higher animal world is the happiest world while it lives.

Very much to the purpose at this point are the facts to which Mr. Wallace has called attention in his comments on "The Ethical Aspect of the Struggle for Existence." He thinks that these supposed miseries of animals "have little real existence, but are the reflection of the imagined sensations of cultivated men and women in similar circumstances; and that the amount of actual suffering caused by the struggle for existence among animals is altogether insignificant." In evidence of this opinion he recalls the fact that "animals are entirely spared the pain we suffer in the anticipation of death — a pain far greater, in most cases, than the reality." He refers also to "their almost perpetual enjoyment of their lives;" and to the further fact which consideration of the nature of their enjoyments indicates, that "animals, as a rule, enjoy all the happiness of which they are capable." He draws this conclusion concerning the ethical aspect of the struggle for existence: "What it really brings about, is, the maximum of life and of the enjoyment of life with the minimum of suffering and pain. Given the necessity of death and reproduction — and without these there could have been no progressive development of the organic world, — and it is difficult even to imagine a system by which a greater balance of happiness could have been secured."[1]

In connection with these remarks of Mr. Wallace we may recall the reflections which have impressed other naturalists, that the larger part of the waste and destruction of animal life according to nature's beneficent provision is pre-natal, occurring amid germs and seeds and embryonic forms before the rise or growth of individual feeling; and also the fact that even the higher animals apparently have no conception of death. Knowledge of death, and the pain of it, is acquired

[1] *Darwinism*, pp. 36 *sq.*

only by man, and by man also is acquired the spiritual power to overcome the fear of it. In other words, knowledge of the full mystery of evil is given only to that being to whom is given also power to rise above it. We who can see how dark the cloud is, have acquired power also to believe that the whole mystery of evil has its hour only in the infinite sunlight, and the shadow of it passes away.

To the same purpose we may refer again to an interesting post-Darwinian study of the play of animals. The fact that animals, as well as children play, is familiar to all observers of the ways of animals. Any kitten is proof enough of it; but how play ever came into the hungry, struggling, cruel animal world is another question which has puzzled our naturalists; and the moral significance of the introduction of play as well as work into the animal kingdom, is something which seems generally to have been overlooked. An easy answer to the question why do animals play, would be, because of the superabundance of animal spirits. It was the poet Schiller who first gave this simple account of animal play. Herbert Spencer elaborated it among his universal formulas for the comprehension of all things. He supplemented the answer with the suggestion that while surplus energy is the first condition of animal play, the precise forms of play are determined by imitation. Imitation, combined with animal spirits, brings about this happy result of playfulness, which we regard as a sign of the moral value of life. The new-Darwinians, however, are not content with so naïve an explanation of animal play; and one of them, Professor

Groos, sees in animal play something more than a mere incidental phase, or happy accessory of the development of life. It all comes under natural selection, he would have us understand. Play has its necessary place and function even in the struggle of existence as "the young form of work." As Mr. Thomson puts it: "The play period is an apprenticeship, a preparation for adult life, with the great advantage that mistakes are not of serious moment. Throughout the ages those kittens and other young carnivores which hunted best in fun have hunted best in earnest; the non-players and the bad players have been eliminated. Play is thus a rehearsal without responsibilities, a sham fight before the battle of life begins, a preliminary canter before the real race. In short (as Groos says), while there is some truth in the assertion that animals play because they are young, it is perhaps as true that they have a period of youth in order that they may play, and the forms of play have been defined in relation to the realities of adult life."[1]

This naturalistic account of the origin of play in the animal world illustrates the beneficent working of the severe laws of natural selection and the elimination of the unfit. It is another instance of the goodness in which nature's severity issues. Indeed the old riddle which Samson proposed to the Philistines might be used as a scientific statement of one of the moral enigmas of the creation; for it is strictly true that out of nature's strength comes forth her sweetness. As in the body of the lion were found the bees and the honey,

[1] *Science of Life*, p. 210. See Groos, *The Play of Animals*, p. 75.

so from what may seem at times to have been the fierce power and the cruel hunger of nature has come forth in time the hum of pleasurable existence and the sweetness of her life. As we owe to the severe mercies of natural selection much of the beauty of the flowers and the songfulness of the birds, so to the necessities of conflict, to the hunger and peril and strife of the organic world, we are indebted for the playfulness of the higher animals. Play has entered in as a part of the very struggle of existence. It is not therefore something to be apologized for as though it were but an incident, or a recreation; play first found place in nature because of its utility; and as a part and happy issue of the struggle of life, its value is enhanced as life ascends, the period of it being prolonged in the higher and domesticated animals. With us the power to play becomes a spiritual gift which may be inwardly exercised through all life's hungry years, and at last in the religious dreams of old age be still part of the soul's free preparation and expectancy for the life beyond. Indeed the origin and use of play in nature furnishes fine text from which discourse might be made concerning the higher meaning and value of play as nature's happy gift to our spiritual life and freedom. As of the higher animals, so even more of men and women, it may be true, that those who play best may succeed and survive best. Certainly so good a gift, which nature was so long preparing, as the power to play well, ought not to be cheapened in our fashions, or tainted with commercialism and vulgarized, as in the habit of betting. The animals do not play from any adventitious interest borrowed to give zest to their frolicsome motions. Only man vulgarizes play. Like everything else which is natural, play ought to be idealized; it may have place and use in our best and most spiritual life. You remember that it was a stern prophet of old who added this fine touch to his description of the New Jerusalem, the city of Truth: "And the streets of the city shall be full of boys and girls playing in the streets thereof."[1]

To continue in such practical discourse concerning our true use and idealization of play, might lead us somewhat aside from our immediate argument; we return to that, and claim the coming at length of play into animal life as another sign that nature's vast process has happy character; and happy character, measuring it on the scale of vital values, is an indication of good purpose or intent, that is, of moral character in nature.

As naturalists look into the lower organic world they cannot fail to be impressed at times with the apparent loneliness and joylessness of all that silent realm. There is only ceaseless motion and hunger there — an endless passing and ceaseless reproduction of forms, little sensation, no sound, nor voice, no up-leaping for very joy, no comradeship, no music, no play in all that early world of the *Infusoria* and the lower organic realm. But when into this drear and silent world play has come — play bright, social, pleasing, sparkling — it is like a new dawning of life. Here is another beam in the darkness which shall grow. Here is one of life's first hints of divinity. Play is one of the first proofs of a benevolent God in the animal kingdom. For life,

[1] Zech. viii. 5.

beginning with hunger and becoming playful, has thereby taken a long step forward towards happiness. The end of that way of life shall be satisfaction. The height, lost in the light above, is blessedness.

Play therefore, let it be repeated and emphasized, when it came into a world of hunger and of death, came as one of life's first promises, and it marks, with all the spirit and fun and joyousness of it, a distinct gain, a moral gain, of evolution. This is not a sign to be overlooked and passed by, if one would judge truly the character of the world-process.

Again, as the second answer to the doubt which the dark side of life often compels us to feel, we must bear constantly in mind that characteristic of direction which we have described as the law of limitation. In any conceivable world a directive Intelligence would work under limitations. Creation is itself limitation. A thought spoken, an idea wrought into marble, an argument put into a book, an imagination construed in a poem, — this is not only a creation by the free spirit, but it is also a limitation of it. All manifestation is self-limitation as well as self-revelation. This is as true of infinite as well as of finite mind. Divine ideas objectified in matter, expressed in suns and stars and living cells, bound together in one harmonious order of nature, fall under the same self-imposed law of creative limitations. The divine word cannot be recalled. What God does He does forever. It is enough if we may know that the sculptor's thought has wrought to noble use the marble in which it is formed, or the poet's genius has formed a happy harmony of words, or the divine ideas made all things work together for good. With lesser creations, indeed, such as a picture or a book we may say, That is as well done as it could be done; colors or words could be used no better. Our limited knowledge may not allow us to go so far as that and to say of nature, as some theologians have done, — It is the best possible world. Nor will it permit us to deny that it is. We do not know. We may reason philosophically that it must be. But scientifically it is enough if we can find reason to think that it is a good world; that on the whole life works to good purpose; that the ascent of nature is a distinct moral gain of happy sentiency. Under the limitations of nature, as we know its matter and its laws, life has advanced in vital worth and power of joy. That is its marked and predominant character. We cannot reasonably deny this revelation of its moral nature from any supposed possibility of some better world made out of some fancied more tractable matter. There may be other and better worlds than ours, for aught we know; and also this earth and our life here may have, unknown to us, some useful adaptations, some preparatory service to render to other spheres of being, very much as we know that the lower orders of nature minister to the higher, and prepare the way for their coming. But in the midst of the mystery of evil which waits to be revealed, we may be reasonably content to observe the indications of good intention in the constitution and course of the world as we find it, and to judge whether already, and within the limits of it which we may measure, nature has succeeded not only in evoking life, but also in so guiding it and disciplining it that on the whole it lives to good purpose and grows capable of better and larger happiness.[1] We may apply to the existing universe, so far as we have knowledge of it, the remark concerning the strawberry which Izaak Walton applied to his "quiet, innocent recreation" of angling: "Doubtless God could have made a better berry, but doubtless God never did." We do not know that a better world possibly could have been made; but like the strawberry, which the angler picked by the bank of the brook, the world which God has made is good, and the goodness of life is sweet to our taste.

It would lead beyond the limits of our immediate argument from nature to follow the signs of moral direction towards ends of higher vital value in the life of man and through the new Christian and spiritual evolution of human history. We may glance, however, along this line of human development long enough to observe that the same principle of beneficent vital increase obtains in man's history. We can grasp with firmer confidence a principle which is seen to hold good, up and down, through all the spheres and orders of the creation. Direction in the cell and direction in the world, providence in the least and providence in the greatest, confirm each the other, illustrate one another,

[1] Mr. Romanes regards the problem of the origin of evil as mitigated by the Darwinian doctrine; and he adds this suggestion: "But even here we ought not to lose sight of the possibility that, if we could see deeper into the mystery of things, we might find some further justification of the evil, as unsuspected as was that which, as it seems to me, Darwin has brought to light." *Essays*, pp. 56–57.

and disclose the same motive of benevolence in which the moral order of the cosmos has been constituted.

If we apply to human history the same scale by means of which we have been measuring evolution in nature, viz., that of increase in vital values, unmistakable evidence of progress will be brought out; and we hold that such advance in the worth of life is clear sign of the moral character of history as a whole. There exists in the world at the beginning of this new century larger human capacity for living, and more joy in life than existed a hundred years ago, or nineteen centuries ago in the dying Roman empire; or in the earlier ages when Abraham sought a better country, not knowing whither he went. In making this comparative estimate we do not overlook the pessimists, or, passing them by, as perhaps it is always best to do, we would not ignore the too familiar facts which show how hard and impoverished life must still be for large numbers of mankind. Nevertheless, this comparative estimate, measured by the scale of vital values, holds true of our human history, as it does of the whole nature-process before us. Without stopping to argue in full the position that history has been on the whole progressive in human capacity for living and in human joy of living, the advancement may be put before us by two single points of comparison. We refer for one to the power of the rich man to live largely and to enjoy life generously at the dawn of this century, much more than was possible in the age, let us suppose, of Crœsus. What good could Crœsus have done with all his wealth? What opportunity for large, enjoyable use of it did the world, so far as it was then evolved, offer to Crœsus? Not much. Men did not know enough in his day to use wealth to the best advantage. A dollar had little worth in his time for benevolent purposes. It could not have been made to go far. It had comparatively little value even for self-enjoyment. Crœsus of old had to hoard his wealth; he was not called on every day of the year by numerous solicitors from all over a great world, and he could hardly have helped being a miser. It was so with father Abraham in his day. His flocks multiplied, his herds increased; but besides taking good care of his own, how little opportunity Abraham had for charity — what a narrow world was his even for self-enjoyment, or a rational use of his means in recreation, art, music, and a thousand ways in which man now may himself be happy and make others happy. In short, the increasing worth of money for all noble uses is itself an unmistakable sign of progress.

A similar comparative estimate in favor of progress may be made from the other side of human life. Grant that life for the man at the bottom is far from that which it should be, and which it may yet be made to be. Still the average man may live more now than ever before. It is not simply a question of comparative wages, or even of comparative possessions. A comfortable use of the world tends to increase for the great majority at least of mankind. But more than this, we can say that almost any child — alas! we may not yet say every child — but the many children of men are born in these latter days into a world wherein life may become for most of us something larger in its outlook, richer in its sympathies, nobler in its aims, and more joyous at least in its struggle and its hope for humanity, than it was in bygone ages, or among the first savage colonies of men, or even within historic times. On an ancient Assyrian tablet there is a broken line with but one word of it left to be deciphered, — and that one word renders that old world near akin to ours; — it is the word, Evil. All the generations of men have known that word. In some far, bright, future century — should there be unearthed a buried monument of the century just past as record of our world now — that historic word, evil, would still be found written among its lines; but over it would be seen written in larger letters, as the most distinctive word of the present time, that other word, which humanity now begins to know as the greatest of all, — even Love.

CHAPTER VII

THE SIGNIFICANCE OF THE BEAUTIFUL

There is one aspect of direction in nature at which we have not yet looked; but we should miss a fine sign of reason in the world, if we should fail to see it. It is the presence and the higher significance of the beautiful in nature.

It was one of the thoughts of the profound Pascal that an inch or two more or less on Cleopatra's nose would have altered the history of the world. Beauty certainly has been one of the historic forces; but we shall not attempt to measure the influence for good or evil which beauty may exercise in the thoughts of men's hearts. Our present inquiry is determined by the scope of our argument from nature. From what power has natural beauty come, and to what end has it been born in the evolution of the world? What energy has called it forth, in what modes has it been fashioned, and of what character in the direction of nature is its presence a sign?

The Darwinian science seems to have hit upon an easy explanation of the fair colors and variegated adornments of many flowers and much animal life. We look first then, in our inquiry concerning the significance of the beautiful, to this account of its origin and use. It is the utilitarian theory of it.

The prevalence of the beautiful in living nature is regarded as due simply to the fact that its cultivation has been found to pay. It is true that in many interesting instances among the flowers and the birds we may perceive some good use in their beauty. Some lines or colors which we regard as beautiful, have been of vital advantage to the plant or the animal, and consequently they have been naturally selected and enhanced. It is not the least of the obligations which all students of nature owe to Mr. Darwin, that he opened up in this manner an almost unsuspected way of approach to the realm of the beautiful. He was the first to give a clear scientific account of a method of the manufacture of the garment of beauty which nature seems never weary of weaving. There are three natural factors which are supposed to be busy in its production.

One of these causes of natural beauty is protective coloring, including warning colors and mimicry. We need hardly do more than mention this factor. Every woodsman knows the difficulty of distinguishing many kinds of game from the grasses and foliage amid which they hide; the common woodcock, for example, reproduces the pale ashy colors of the fallen leaves so "mingled with the dark browns and warm yellows of the fresher leaves" that the adornment of the woodcock answers finely the purposes of concealment. So also birds which inhabit the Egyptian deserts are so shaded down and mottled that they are hardly to be distinguished from the sands and stones, where they safely find their hiding-place even under the glare of the sun. Fine pencillings and shadings, and richly blended hues in the diversified plumage of the birds have resulted apparently from their protective value under the law of natural selection. The useful mimicry of color is carried to an exquisite perfection among the insects. There are beetles which are like drops of dew; and butterflies which resemble tropical leaves so closely that no two of them correspond exactly in their tracings, any more than the leaves do, while some of them mimic even the marks upon the leaves produced by the ravages of insects or of vegetable moulds.[1]

Another factor in the production and diversification of natural beauty Mr. Darwin found in sexual selection. In this may be included the use of color and markings and distinctive bird-notes for purposes of recognition. The facts which have been adduced in evidence of this reason for the beautiful, belong to the romance of animal life. "All naturalists," Mr. Darwin remarked, "who have closely attended to the habits of birds, whether in a state of nature or under confinement, are unanimously of opinion that the males take delight in displaying their beauty." We are reading here a chapter in the natural history of courtship. For charmed by some splendid top-knot, or fluttering and fantastic motion, puffing out of feathers of neck and breast, or ornamented comb, graceful plumes, elegant ear-tufts, beautiful ruffs and collars, spots of gold, or brilliant contrasts of plumage,

[1] See Wallace, *Darwinism*, pp. 190 *sq.*, for instances. In the Natural History Museum at South Kensington, London, there is an interesting collection to illustrate protective coloration; some insects resemble so neatly the leaves and twigs that one has to look sharply to distinguish them. One may notice for example the exact resemblance of *Umbonia spinosa* to a rose thorn.

the female bird, so our inquisitive science has found out, will make her choice of a mate, and by her happy choice tend to perpetuate in her nestlings the beauty which first won her little bird-heart. We are not unwilling to listen to a science which introduces us to courtships and loves of the birds so seemingly human in their methods, as well as in their crosses and difficulties; —methods of bird-mating, at least, which involve parties on the lawn, dances and antics, and meetings at times in quiet secluded spots, during which all the arts of attraction are practised, and in the course of which some birds will become so absorbed that they will appear almost blind and deaf, and others will grow quite frantic, while rivalries not infrequently end in battles; and likewise from such scenes, in too close correspondence, perhaps, to our human ways, some male birds will retire to some sequestered place in gloomy disappointment, and some females, unable to make a choice amid so many offered attractions, will fly away to dwell alone as spinsters in forlorn habitations. Perhaps from our knowledge of human fashions we may find the scepticism of Mr. Wallace more probable when he raises the question whether the individual tastes of hundreds of successive generations of female birds would not necessarily have tended, not to the definite patterns of beautiful colors and markings which nature has to show, but rather to confusion of colors, and the production of a speckled and piebald beauty.[1]

A third factor, on which with Darwin, Mr. Wallace

[1] Mr. Wallace rejects as unproved Darwin's supposition of Sexual Selection as a cause of color development. *Darwinism*, Ch. X.

and most naturalists lay much emphasis, is the use of color in the cross-fertilization of plants. This cannot be better put than in Mr. Darwin's own summary of his inductions. "Flowers," he says, "rank amongst the most beautiful productions of nature; but they have been rendered conspicuous in contrast with the green leaves, and in consequence at the same time beautiful, so that they may be easily observed by insects. I have come to this conclusion from finding it an invariable rule that when a flower is fertilized by the wind it never has a gayly colored corolla. Hence we may conclude that, if insects had not been developed on the face of the earth, our plants would not have been decked with beautiful flowers, but would have produced only such poor flowers as we see on our fir, oak, nut and ash trees, on grasses, spinach, docks, and nettles, which are all fertilized through the agency of the winds."[1] This is certainly the best apology for the existence of insects that could be imagined.

Such in brief is the utilitarian theory of the origin and development of the beautiful in living nature. It is supported by a large number of observations, it fits into many curious adaptations, and its partial truth, at least, cannot be denied. This theory, however, has received since Darwin much criticism from closer investigations; and the larger question has not yet in any of the writings of the evolutionists been argued out, whether it is a sufficient theory of the beautiful. Is it co-extensive with, can it be so stretched as to comprehend all the phenomena of beauty in nature? The problem

[1] *Origin of Species.*

thus presented is more fundamental than the questions which are presented by mere criticism of the details in Mr. Darwin's account of the natural origin of the beautiful among the flowers and the birds. Granting that beauty is shown to be of some use in the struggle of existence, vegetable, animal, and human too, we would inquire further and more deeply, whether the utility of it affords a sufficient principle of beauty? Admitting, as far as the facts warrant, that nature has made good, economic use of beauty for the maintenance and victory of life, does this utility of it account for all of nature's superabundant beauty? Or must we find some love of it for its own sweet sake near to nature's heart? What other account of it can you give? said a botanist, when asked a question about the violets; but let us first see how far his knowledge of the use of beauty among the flowers may go.

We may mention several particulars which show that even on the field where beauty is of apparent use, nevertheless all of the beautiful cannot readily be explained by its utility.

For one thing, it does not render sufficient account of those lines, markings, and hues, which in the structure of many vegetal and animal forms have no apparent or imaginable relation to the uses of life. For instance, the fine proportions in the architecture of the shells of those minute forms of life, the *Foraminifera*, or the sculpturings of the *Vorticellidæ*, are not easily to be explained by any advantage possibly to be gained by such artistic beauty; for in such life "there is hardly eye to see or sex to be attracted.[1] This would seem especially to be true of forms of perfect loveliness which naturalists in their dredgings have brought to light from darkest depths of the ocean. We may see — our human eyes the first to behold them — bits of coral which for ages have been hidden nineteen hundred fathoms deep at the bottom of the sea, the patterns of which are woven as delicately as the finest lace.[2] One of these specimens of coral, which was brought up from the depths on the voyage of the "Challenger," resembles (as a child to whom I pointed it out exclaimed) a rose window; there was appearance as of a star at the centre of it, and fine tracery of radiating lines, and a circular pattern of shadings around its border; — a cathedral window might have been drawn from the miniature carving of this bit of coral, upon which in its secret of beauty no light had ever shone. Of what conceivable use to it was its perfection of design? Similarly among fossil forms ornamental lines have been carried out, as Professor Shaler from his studies of them declares, "far beyond the limits of utility." He is so impressed with the "fashion motive" of their adornment, that he compares it to "the work of the human fancy." [3]

Various pigments and optical hues occur throughout the entire range of the lower organic realm. Bacteria show "often surprisingly brilliant colors." *Algæ* contain varied pigments: the "reddish-pink fronds" of one

[1] Sandeman, *Problems of Biology*, pp. 131–132.

[2] *Leptopenus Discus.*

[3] *The Individual*, pp. 315–317.

species of them we may often find "cast up on the seashore during the summer months;" the translucent hues of sea-anemones, jelly-fish and corals are well known; not so familiar, but possessing attractive beauty to those who know them, are the colors of a large group of worms (*Nemertea*). One who has made a study of them writes, "The gradation of color in the various parts of a single specimen" is "so subtle that enthusiasm as well as skill is necessary in the artist who sets himself to the task of faithful delineation."

The color-scheme is thus seen to be part and essence of the order of nature; beauty is one of nature's original and constitutive notes. Color is elementary, structural, physiological; it is an essential element of life, before ever it becomes of use in the struggle for better life. In other words, color has vital value before it gains survival value.

Autumnal coloration, likewise, has no direct relation to use; it is not in itself advantageous to the trees. It may possibly be regarded as an incidental result of a vegetative process which is advantageous to the trees; but it is an incident of beauty which nature sometimes lavishes upon the forests with a prodigal hand; and it is one of those extraordinary and superabundant incidents, at least, of the creation, which it is difficult to regard as the result solely of natural selection.[1]

It is rightly argued that if nothing has become beautiful in the living world except where its beauty has

[1] See Miss Newbigin's *Colour in Nature*, p. 66. The facts summarized above have been drawn partly from her pages; many similar ones might be added.

been proved by the severe test of natural selection to be useful, then the beautiful will be found where it is of use, and nowhere else. But, as matter of fact, we find beauty existing without utility, and also we find less conspicuous and less variegated forms succeeding despite their lack of beauty. So the facts of nature seem to be larger than this theory. For example, many conspicuous flowers are not dependent upon the visits of insects for their cross-fertilization, so that in such cases they cannot have gained their bright colors as attractions for the insects. Thus the family of *Asclepiadæ*, it has been argued, present flowers conspicuous for their size, coloring, and grouping, yet they are self-fertilized; their brilliant beauty, therefore, must be due to other causes than any possible use of it for fertilization through its attractiveness to insects. Upon this theory it is a useless and purposeless ornamentation. Besides this, the ornamentation of many parts of plants seems to have no known or conceivable utility for the life of the plant, any more than the carving of a sword-handle has to the purposes for which a sword is made. In many blossoms there are subtle markings, delicate shades and hues, marginal lines, and spots of color, which are of no obvious help in guiding the insects to their honey, but which are the perfection of their beauty to our eyes. Conspicuousness rather than harmonized color, brilliancy rather than loveliness would seem to be best adapted to the uses of cross-fertilization. The parts of plants upon which insects do *not* alight, have not been left untouched by nature's artistic grace; the under sides of many leaves show perfect finish; and the veins are woven into exquisite patterns, while even the stems are often sculptured and adorned with a beauty all their own; — and what shall we say more of the richness of some of the foliage plants, or the grace of the wind-loving reeds and grasses, or the poetry of the rhythmic ferns, or the aspect of gentleness lent to the strength of the rocks by the softness of the mosses, and the fine etchings of the lichens; — as though nature, hiding an artist's instinct ever in her heart, could touch nothing without adorning it, and over the primeval stones and granite strength of her architecture would throw suggestion of the coming bloom and fragrance even in her earliest vegetable moulds and fungi.[1]

An instance has been cited of seemingly disinterested beauty — beauty existing not for use, but for its own pure sake — in the common violet. A great variety of plants possess two kinds of flowers, the one conspicuous, and the other inconspicuous. The cleistogamous, inconspicuous blossoms appear among the violets during the summer and autumn when all the more brilliant flowers are gone. "The one flower, the conspicuous one, which our children delight to gather in the springtime, has everything in its favor — honey and a beauty of color and of smell that has passed into a proverb — and it opens its blue wings to the visits of the insect tribe in the season of their utmost jollity and

[1] Many curious instances of coloring which it is difficult to explain solely by the principle of natural selection are noticed by recent investigators; e. g., see Kassowitz, *Allgemeine Biologie*, B. ii. ss. 64, 72, ff. Weidemann's *Annalen Farbenphotographie*, 48, 2; *Centralblatt für Physiologie*, 1895, s. 666. The effect of light in producing coloration needs to be more carefully studied.

life. The other has everything against it; it is inconspicuous, scentless, ugly, and closed. And yet which succeeds the better? which produces the more seed? The cleistogamous, and not the brilliant flower; the victory is with ugliness, and not with beauty."[1] So it has been argued; but a botanist replied, Though the fact be truly stated, it is not fairly argued. The victory in the fertilization of the violets and some other flowers is neither with beauty nor with ugliness, but rather with that kind of blossom which at any particular time was best adapted to its environment. He would proceed to inform us that nature in this respect has shown great adaptability; that she has two ways of maintaining her plant life according to circumstances; and that these ways alternate as the one or the other may be most useful in any place or time; that some Alpine plants, for instance, which lower down, where insect life abounds, have conspicuous blossoms, and rely upon them for fertilization, will manage to survive in higher altitudes, where insect visitations are not sufficient, by adopting the alternate method of self-fertilization within their closed and ugly blossoms. Mr. Wallace has dwelt upon this power of some plants to change their habits according to their needs.[2]

Heeding whatever the botanist may observe concern-

[1] Mr. Justice Fry, *Cont. Rev.* vol. xxxvi, 1879, p. 581.

[2] The suggestion might also be ventured that the highly colored blossoms have some lingering utility as means of the occasional rejuvenescence of the violets; as at times some of them are fertilized and fresh seeds produced. Mr. Wallace explains the heightened colors of many Alpine flowers as a consequence of their need of greater conspicuousness to attract the few wandering butterflies when the bees are less abundant. *Nat. Sel.* p. 403.

ing the utilities of these different kinds of flowers, we touch a deeper question, which such arguing does not reach; and possibly there may lie here a hint also of simpler truth of beauty than we might suspect. For let us ask in reply again, why has nature been so prodigal as to adopt this double mode of fertilization, and even under conditions where the cheaper method of self-fertilization might suffice, does she develop the more costly method of cross-fertilization by insect visitations to blossoms upon which color has been so lavished? Why does nature cling to this more expensive ornamental way, and not give it up until seemingly she has to throw aside her sweetly scented flowers, and return to her closed and common blossoms only where among the too crowded fields her violets cannot otherwise keep up their frail existence, or where her plants must survive among the severities of the Alpine frosts? Why did nature ever care to strike at all into this much more costly way of beauty? Plant life could have been more cheaply maintained; — why the extravagant way?

The puzzling complexity of this problem is admitted by Mr. Wallace; but he argues that the two methods of self-fertilization (by means of plain, economical flowers), and of cross-fertilization (by means of conspicuous more extravagant blossoms), are both necessary under varying conditions to the "vigor and fertility" of plants.[1] But even upon his own statement of facts, cross-fertilization, with its "highly complex modes," and "so much cost of structural modification," seems often to be a needlessly extravagant method of nature. It is difficult for

[1] *Darwinism*, pp. 321 *sq.*

the most enterprising advocate of natural selection to show that the beauty lavished upon the flowers is everywhere good economy. Nature seems to proceed like a happy spendthrift of beauty, as she scatters bright colors among the flowers of the fields. It would seem as if beauty nature must have and keep at almost any price, save the very life of the plant. It seems as if nature would cling to her beautiful children with all her heart. Poetry this, it will be said, but not science; but let us look further and see.

The inadequacy of Darwin's theory of the origin of beauty from its use — the partial truth only of it — appears further from some curious experiments which have lately been very scientifically made from the other side of the matter, which Mr. Darwin neglected, that is, from the insect side of the question. Insects have had their eyes examined lately, and their power of appreciating the beautiful has been carefully tested. To some extent these experiments confirm the Darwinian view that conspicuous blossoms attract the visits of the insect youth, as Paley calls them. But, on the other hand, these examinations of the insects' powers of vision show the inadequacy of this theory of the evolution of the beauty of the flowers. For they do not have eyes good enough to distinguish between, and so to cause the natural selection of, the finer hues and the perfect loveliness of the flowers. Mr. Wallace perceived that the evidence failed to show anything in the insect sense of color corresponding to our æsthetic sense of it, and that consequently there could be no choice of flowers by the insects simply for their beauty's sake. He says: "All that has been proved or that appears to be probable is, that they are able to perceive differences of color, and to associate each color with the particular flowers or fruits which best satisfy their wants."[1] To this extent, as helping to produce distinctly marked flowers, or blossoms of easily recognizable colors, the selection of them by the insect tribes doubtless has contributed its part to the evolution of the beautiful. The insects are not wholly color blind; but there is much in the loveliness of the simplest flower for which the butterfly has no eye. A French biologist, Professor Plateau, in recent contributions gives a large number of observations in confirmation of his statement that insects are not attracted by the sense of sight. "Pollinating insects," in the instances which he observed, "made their way at once to the flowers which contain the honey without being visibly guided by the showy organs" of the plants; "while, if these are removed, it does not appear to make any material difference in the number of insects which visit the inflorescence."[2] This observer concludes that color is not the primary factor in attracting insects to flowers. "Although flowers are undoubtedly seen by insects from a distance, either from their color or from some other contrast with their surroundings, when they once reach the flowers, it is perfectly indifferent to them what their color may be — blue, red, yellow, green, or white — if they differ from one another in no other respect." Indeed pungent odors

[1] *Darwinism*, p. 336.

[2] *Mem. Soc. Zool.*, France, xi, 1898, pp. 339–375; xii. 1899, pp. 336–370, see *Jour. Royal Mic. Soc.*, 1899, p. 298, 1900, p. 319.

may have more influence in leading to cross-fertilization and to sexual selection than do the colors of flowers and animals; as a male moth is known to be drawn from an almost incredible distance to meet the moth of the female species.[1]

The Darwinian theory of the origin and growth of the beautiful simply because of its utility, has failed to observe the good Baconian rule of attention to negative instances. It is true in part, but only in part. It does not understand all the loveliness of the flowers, or the splendors of plumage among the birds. Utility, in a word, accounts for some beauty, but not for the perfection of beauty in nature.

How, then, the botanist may ask in turn, can you account for the beautiful, if not on the principles of natural and sexual selection? We may answer, Is there not here sign of some neglected or unknown factor of evolution?

The inadequacy of natural selection to account for the coloring of plants and animals, is perceived by many naturalists, who seek for other and deeper reasons for its origin and development, — its utilities being regarded as incidental and secondary adaptations rather than as primary sources or efficient causes for its existence and growth. The latest researches require no modification of the discriminating remark which the eminent botanist, Professor Asa Gray, made in 1882: "For all that yet appears, we may be indebted to bees for the beauty of our gardens and the sweetness of our fields, much as we are indebted to the postman for our letters. Corre-

[1] Shaler, *opus cit.*, p. 127.

spondence would flag and fail without him; but the instrument is not the author of the correspondence."[1] Color is recognized by many recent investigators as something more closely interwoven with evolution than the mere utilitarian theory of it had imagined. Color is a structural fact; there is a physiological line of beauty; the whole color-scheme of nature needs to be studied anew in its primary significance as an original and constitutive factor in evolution. A potency and power of coloration is thought by some to be an inherent property of protoplasm; while its development throughout nature is due to these inherent properties and the stimuli of external conditions, such as heat and warmth. There is an order in the development of nature's color-scheme, independent of its use to life, — an order which is definite and predetermined in the constitution of matter.[2] If we regard the universe with the Platonic philosophers as a divine idea, we should be true to our physiological knowledge of the development of fair colors, if we should say that the beautiful is inherent in the idea, and that its manifestation is revelation of the divine idea in one of its essential and eternal elements.

The subordinate rôle of natural selection in the production of protective coloring is further indicated by the larger influence which recent students are inclined to attribute to the photographic sensitiveness of organic substances, by means of which, as upon a photographic

[1] *Con. Rev.* vol. xli. p. 606.

[2] See Simroth's view as given by Miss M. I. Newbigin, *Colour in Nature*; his paper *Ueber die einfachen Farben im Thierreich* was published in the *Biol. Centralbl.* xvi (1896), pp. 33–51.

plate, an organism may reproduce on its surface the colors of its surroundings. Thus it is suggested that "a caterpillar may be like its environment, because its skin photographs that environment by means of the sensitive compounds of its own tissues." [1]

Furthermore we urge if the utilitarian theory of beauty proves thus to be inadequate even on the single limited field in which the beautiful may be seen to minister to the useful, this theory of it breaks down utterly when we survey the whole extent and superabundance of the beautiful throughout nature. It has no possible application to a vast number of forms and arrangements on the earth and in the sky which give to us the impression of beauty. We must seek further for the explanation of this universal tendency to the beautiful in the natural world. We find beauty manifested in the structural lines, involved in the elemental groupings, and abounding everywhere through all the orders of the creation. Nature, it would seem, even in her

[1] Miss Newbigin, *opus cit.* p. 312. See Wiener, *Farbenphotographie durch Körperfarben*, etc. *Ann. Phys. u. Chem.* lv (1895), pp. 225–281. Also Eimer, *Organic Evolution*, pp. 142 *sq.* Eimer holds that a color-adaptation may be produced without any selection through nerve stimulation — stimulative coloring. An excellent summary of our present knowledge as well as ignorance of the causes and methods of coloration in nature, is to be found in Miss Newbigin's book on *Colour in Nature*, London, John Murray, 1898. It contains a trenchant criticism of the relation of facts to theories, concluding with these words, which are well worth quoting: "In spite of the fluency with which so many people talk of the meaning of color in organisms, the subject is as incomplete on the theoretical as on the physiological side. It seems reasonable to believe that the two deficiencies are related, and that a little more physiology will arm the theorists with better weapons. In the meantime, we cannot end a book on Color more fitly than by an appeal for more facts."

elements cannot help being beautiful. In her first motions she follows lines of beauty. Nature is constituted in beauty. Consider for example the symmetry and grace of her least visible molecular combinations. If you have watched in the microscopic field the processes of crystallization, you will have beheld even there a primal revelation of beauty. In the course of crystallization elemental designs unroll like a deftly woven tapestry. There is beauty in the formation of the mineral salts which certainly has no special and selected adaptations to their utility, either to the crystals themselves, or to their medicinal effects upon us. There is in the beginning formative beauty — beauty as of symmetrical and thoughtful design — in the elements of the world. We may notice traces of this original artistic tendency of nature in the touch of the frost upon our window-pane, or in the exquisite forms of the snow-flakes that flutter down from the clouds. We may find evidence of an elemental and universal structural beauty in the lowest vegetable forms which may be sifted from the mud at the bottom of a pool, or gathered from the green slime on its surface. A diatom, that least thing in the kingdom of the plants, discloses under the microscope exquisite markings and shadings, which render it always a pleasant thing to behold. And the little thread of *Spirogyra*, taken from the green slime floating on the surface of a dirty stream, has to reveal to us a line of spiral green, lovely as a necklace. No strings of pearls are more pleasing than some of the threads and beads of color in the grasses.

Nature is beautiful even in that which is least. And when we look up from this infinitesimal finish and perfection of beauty to the larger aspects, the broader masses of coloration, and the more magnificent proportions of nature's architecture, the same irrepressible and universal tendency towards the beautiful everywhere around us breaks forth into revelation. Day uttereth it unto day, and there is no voice nor language of nature where its speech — this divine word of beauty — is not heard. We see beauty alike through the microscope, the spectroscope, the telescope; we see it wherever we open our eyes to look. The etchings, as of a skilled graver's hand, upon microscopic shells answer to the sublime symmetries, as of the great architect's idea, in the glories of a constellation. The lines and colors of the spectrum, as they may be spread before us through the prism, are in harmony with the revelation which the heavens make to our uplifted eyes of their majestic order. Rounded hills, mountain peaks, lovely valleys, lights and shadows over the fields, splendors of evening clouds, and the beauty as of holiness in the dawn, — all declare the presence and the power of some indwelling principle of the beautiful in nature.

Nor need the occasional presence of ugliness give occasion for mistrust of this universal existence of the beautiful. When Mr. Wallace[1] reasons that because many objects are destitute of beauty, some explanation of the ugly in nature must be given if beauty exists for its own sake, he overlooks a key to the occasional existence

[1] *Natural Selection*, p. 153.

of ugliness in this fair world, which his own theory of utility might have supplied. For occasionally the less beautiful form may be the more useful. The abrupt turn of a root over the edge of a rock into the crevice where it seeks for a little earth, may be more quickly advantageous to the maple-tree, which grows up straight and fair from the mountain-brook course, than would have been a more graceful curve, such as its growth might have followed in more favorable soil. Uncouth forms, and homely colors, and even passing manifestations of positive ugliness, as we look upon it, may have momentary part and place in evolution, and consequently have been naturally selected and kept so long as they were needed. But the tendency is always towards the beautiful. Moreover nature is never long tolerant of ugliness. It manifests everywhere a tendency to soften features which are repulsive, to brighten with a touch at least of color that which is dull or drear, and, when all else fails, to bury the ugly from sight. As if to show her inexhaustible splendors, even over commonplace landscape nature will pour a glorifying light; and from farm-house door, looking down the country road unmarked by any loveliness of its own, the eye may behold a sunset which transfigures all. It is as though nature would teach us every day, even in the midst of commonplace, that ugliness is contrary to her heart, and that beauty is her first love to which all her forces are forever faithful. Even her vehement moods and her destructive energies, as well as her sunbeams and her dews, must work for symmetry and grace, — the frost that silences the streams, brings to the winter's landscape a new beauty all its own; even craters of volcanic fires are not black and forbidding funnels of desolation; the demons of destruction have left adorned with rich browns, and ochre, and yellows, and glimmer as of gold, the fissured walls of lava through which they hiss and flame. The destructive forces at which Professor Tyndall wondered in almost religious awe as he surveyed their ancient empire from the lone Alpine peak, have moulded and fashioned the Matterhorn into a shaft of beauty piercing the clouds; and, — has not John Ruskin taught us how irrepressible beauty is in nature, as with the artist's unerring eye he observed that "the disintegration of the mountains under various forces has nevertheless taken place under laws of fair curvature." "A rose," he writes, "is rounded by its own soft ways of growth; a reed is bowed into tender curvature by the pressure of the breeze. . . . But Nature gives us in these mountains a more clear demonstration of her will. . . . 'Growth,' she seems to say, 'is not essential to my work, nor concealment, nor softness; but curvature is: and if I must produce my forms by breaking them, the fracture itself shall be in curves. If, instead of dew and sunshine, the only instruments I am to use are the lightning and the frost, then their forked tongues and crystal wedges shall still work out my laws of tender line. Devastation instead of nurture may be the task of all my elements, and age after age may only prolong the unrenovated ruin; but the appointments of typical beauty which have been made over all creatures shall not therefore be abandoned; and the rocks shall be ruled, in their perpetual perishing, by the same ordinances that direct the bending of the reed and the blush of the rose.'"[1]

What then is the full and sufficient interpretation of the beautiful in nature? What does its natural evolution signify? We answer: It is from reason and for reason. It is expression of reason to reason. It is revelation of the Intelligence that thinks it and loves it, to the mind in us which may perceive it and delight in it. This, and nothing less, is its message and its meaning. Our sciences may trace the laws of its unfolding; our biology to a certain extent may find the method of its evolution. But beauty is a perpetual revelation of intelligence to intelligence. The principle of beauty, wrought into the elements of nature, is one of the ruling ideas of the world. The tendency of nature everywhere to break forth and to blossom into beauty, is one of the leading characters of evolution which indicate its rational and moral direction.

We have left, it may be said, one whole side of the great argument from the naturally beautiful thus far untouched — the physiological side of it. How, it may be asked, is our own æsthetic sense, our perception and delight in beauty, to be explained? May not that have had its origin in mere utility? May not our sense of the beautiful be itself an acquired adaptation of ourselves to our surroundings? May not beauty in our apprehension of it be after all a quite simple physiological affair? So some writers would tell us; as one author, for instance, calmly assures us that our sense of the æsthetically beautiful is to be regarded as "that

[1] *Modern Painters*, iv, § 25.

which affords the maximum of stimulation with the minimum of fatigue or want in processes not directly connected with vital functions," — a perfectly natural explanation of our delight in the beautiful which you might remember the next time your spirit breaks forth into exultation when your physiological heart is panting as you climb at length the very last mountain peak, and gaze around.

Physiology no doubt has its contribution to bring to the evolution of the sense of the beautiful. Let us accept its facts also, so far as in our physiological laboratories of psychology they may be determined. Our æsthetic sense has been evolved, and without breach of continuity, from the lowest organic perception of light and sound. We need not attempt to follow up this development. That has been as yet very tentatively and imperfectly done. But so far as it has been carried, it goes to show that the two sides of the evolution of the beautiful — its acquisition in nature and the power on the other hand of sentient intelligent life to perceive it — have run on together; the one evolution matches the other. And the matching of them is further sign of intelligent direction. Both are met — the color and music of the world, and the seeing spirit and the loving heart — in nature's final revelation of the beautiful to man. It is one complete evolution, and hence its character as beautiful has deep spiritual significance. Physiology has to do with the method or mechanics by means of which the beautiful is perceived; it has nothing to do with the reason in it or for it.

We would like to know far more than the most skilled physiologist can yet show us concerning the great transformation of the outer world in our consciousness. It has always been the enigma of knowledge, how waves of sound or light may break upon the shores of our human consciousness into perceptions and delight in music and color. What magician with potent wand stands at the gateways of the senses to change the world of motions without into the realm of forms, fragrance, and all harmonious sounds within our consciousness? Such is the ceaseless miracle of the transubstantiation of nature to our thought. It ceases to be a miracle only when we recognize it as the regular and orderly communication of mind to mind through nature. Natural beauty can be perceived by the mind within us because it comes from the Mind without us. Beauty is constituted in mind and for mind. It is not simply that ethereal waves break upon the color purple of the eye; there would never be human sense of the beautiful, should the rays of light stop in the eye; it is in the seeing mind that they are taken up, transmuted, organized into the perception and enjoyment of the beautiful. Beauty has no existence except for the soul that sees it. It belongs essentially to the unseen and the eternal, although it is manifested through the passing and the seen. We will not however enter further into the psychological side of the question, for the masters of philosophy — are they not still with us? And that naturalist who has done so much to elucidate and to confirm the Darwinian law of the utility of beauty in nature's economy of life, is among those who makes likewise this acknowledgment in his interpretation of it: "The emotions," he remarks, "excited by colors and by music alike seem to rise above the level of a world developed on purely utilitarian principles."[1]

Let us sum up the course of thought we have been pursuing. The beautiful is a universal characteristic of the natural order. There is a tendency towards beauty in nature. Nature will be beautiful. Biology shows how to some extent use and beauty coincide. The beautiful frequently and in many ways is advantageous to life. Then it is naturally selected and enhanced. Natural science shows partially, at least, how nature may mix her colors; evolution indicates how nature may have woven her variegated threads in the rich garment of life. But beauty is superabundant. It transcends the uses of life. It is elemental, structural, constitutive in nature. The great philosopher, Kant, said that our human sense of beauty is a disinterested sense; we love beauty for its own sake. The same quality of disinterestedness may be ascribed to the character of nature itself as beautiful. Loveliness exists above all its uses for its own sake. Beauty is an end in nature. It is as truly an end in nature as life may be said to be an end in evolution.

Natural beauty we regard, therefore, as more than a physical feature, it is a moral aspect of nature. It is in our perception of it an intellectual relation. It is something revealed not merely to the eye of sense; it is perceived by mind. Canon Mozley, in his fine discourse on *Nature*, has justly remarked that it is "essential to the very sense and meaning of natural beauty that it should

[1] *Natural Section*, p. 415.

be seen;" and "It is visible to reason alone." It is another and everywhere manifest sign of reason to reason in the very structure of nature. It is a revelation in the earth and in the sky to be known when there is a human mind to see it. The beautiful is expression of divinity on the face of nature. No other interpretation of it is rational. Any lesser understanding of it is inadequate. The higher interpretation of natural beauty as having rational and spiritual significance, mistakes no lines of its evolution, and comprehends any scientific knowledge of its utilities, while it does not miss the simple, divine secret at the heart of all the beauty of the world. So through the gate called beautiful we may enter into the temple of God.

The course of our reasoning would carry us one step farther. The discovery of a rational and spiritual principle of beauty, does not end merely in the realm of natural beauty. It binds together as upon another continuous principle the natural and the moral universe. This principle of beauty, likewise, is one of those great principles of the creation which reach through all the spheres and which constitute the unity of the worlds. It reaches from lowliest form to the highest angelic glory. There is one divine thought and love of beauty in the exquisite lines of a diatom, the symmetry of the crystal, the glory of the lily, the hues of the humming-birds, the resplendence of the sky, the spiritual fairness of a human face, and in the perfect beauty of holiness of the saints in light.

Of all beauty in the natural and the moral worlds, on earth and in the heavens, we may say as our last word of interpretation of it, and our highest wisdom, as a little child said when gazing into the beauty of an evening sky, "Mother, I know what makes it so; God gets beneath it and shines through it."

CHAPTER VIII

THE COMING OF THE INDIVIDUAL

The question of supreme interest to us concerns our personal life: what is the worth of our little individuality in the great nature-process? Is our self-consciousness only a passing reflection of nature, — herself seen for a brief moment in her own glass; — the mirror itself being perishable, and the image falling upon it appearing but for a moment, and vanishing as quickly as it appeared? Or is our personal life nature's dramatic climax, and in its worth has something been gained of immortal value? Has all the centuries' science any light to throw upon our personal interest in life?

This is the next topic in the order of our argument. Following the positive method of our discussion, we shall turn again first to the facts of the evolution of individuality, and then seek to know better their meaning.

In general it may be said that evolution through its age-long process has tended towards individuality. The direction of nature has been towards the coming and the reign of the individual. The whole movement has been that way. At the present summit of it, the individual man stands out as its supreme form, and with his face uplifted towards some radiant beyond. This direction of evolution towards individualism arrests attention as another indication of the character of it. How did the individual existence come to be discriminated from the universal flow of energy in nature? What have been the successive steps in the separation of the individual from the mass? What are the characteristics of individuality? And what is the higher sign given in the appearance of the supreme individual in nature — the sign of the coming of man, and of the Son of man? The old question of the prophet we may ask again from a new scientific point of view, Who shall declare his generation? What does the generation of the perfect individual mean?

In this part of our inquiry, as in the preceding chapters, we must search for our answer with painstaking care among the facts observed, as we trace through evolution a process of individuation, and discriminate certain successive stages of it.

One far away step towards individuality is to be discovered in the appearance, one after another, of the separate elements which are now distinguished in our physics.

It used to be supposed that these elements were created in the beginning as distinct things; but our physical science is now in close pursuit of some one original form of matter, from which the elements themselves may have been derived. They are observed to arrange themselves in groups, and to have relations to each other which suggest some common origin. According to our present speculative physics, nature in its distant beginnings was one, and not many. It was uniformity. Yet the one was the mother of the many. Stirring in that vast and void uniformity was some principle of diversification. There was an inherent and primal tendency towards distinctions; and distinct forms became fixed and permanent. The astronomer, Professor Lockyer, holds stoutly to his speculative opinion that the development of the elements may be traced among the stars. In his latest book on *Inorganic Evolution* he says: "It will be seen, then, that the answer to the question, Do the stars show a progression of chemical forms, as the geological beds show a progression of organic forms? is clear and precise. There is a progression."[1] Other astronomers might not share Professor Lockyer's confidence in this answer; chemical astronomy has not translated as yet all the lines of the message of light from the skies;—but it is interesting and instructive to know that evolution now seems to be extending its principles even into the realm of the inorganic, and is finding evidences of progress in the star-dust, and from the orderly development of the chemical elements of the worlds.

In such separation and distinction of the original elements, occurred the first working of the principle of individualization. The appearance of one separate distinct thing, whether it were vortex-ring, or atom of hydrogen, or whatever it was, marks an initial step in the far way towards individuality. It was a step which, once taken, should never be retraced. More, vastly more, was to follow from it than could have been fore-

[1] *Inorganic Evolution*, p. 160.

seen except by the Omniscience which knows the end from the beginning. Yet finite intelligence, now looking back, can see what has come of it; and, as we look back, all the age-long course of increasing individuation from the elemental start appears as one continuous way of the Spirit.

A definite gain, in the process of individuation, was made when a crystal was formed. Nature in the laws of crystallization strikes clearly and confidently into the way of individualization. For in the crystal, form has been won, and clear integrity. Crystallization may be regarded as an announcement in nature of the future coming of the kingdom of individuality. It prepares the way in the wilderness of matter for something greater than itself. The crystal indeed shall decrease, while the organic cell shall increase. But the first crystalline acquisition in nature of varied yet symmetrical structure, permanently fashioned, was a prophetic gain. It was a distinct advance towards something more excellent, when the first crystal in its perfect symmetry was formed. No advance of nature after the advent of the crystal need seem miraculous.

It has been a fashion, especially with theological vitalists, to contrast sharply the course of crystallization and the process of life, and in the supposed spiritual interest of proving some vital force to make the most of these contrasts.

It is true that the formation of crystals of salt is not the same process as the growth of living cells. Differences between them remain, although a German biologist (Bütschli) has lately noted some lines in the formation of crystals of sulphur, which bear a suggestive resemblance to some lines in the division of a cell. It is true further that the laws of crystallization are not identical with the laws of reproduction of life. Laws are never identical in different processes in different realms of nature. But it also holds true that the contrast between the crystal and the cell marks only the distance between two points on the same line of advance. The least in the kingdom of life is indeed greater than the greatest in the kingdom of crystallization; but the one prepares the way for the other; the crystal is a natural prophet of the coming cell. It marks the end of the progress toward individuality in the inorganic world; and the new dispensation of life is already at hand. Nothing more individual, nothing having more distinctive character of its own than a diamond has, can be produced from the whole realm of the inorganic. Beyond any combination of molecules in a nebula, a star, a crystal, the process of individuation cannot be carried in a dead world. A new start must be made, and along some higher way, — nature must go beyond star-dust and diamonds, if it is to press on toward individuality as a goal of its high calling. And, like all great advances in evolution, we shall learn that here also the new kingdom came without observation.

The next approach, beyond the crystals, towards individuality was made through the organization of matter in the cell. That "nursling of time," as it has been called, is so obscure in its origin that no science can tell when or where it had its birth, nor in what environment it was cradled. Life, so far as we may trace its descent, is like Melchizedek, without father or mother; and, although it is of this material world, by its high calling and mystery it seems invested likewise with sacredness as a priest of the most high God.

We are not, however, at this point, concerned with the outlying question of the ultimate origin of life; our attention is now called to the increase of individuation which has been gained in the organization of the cell. It is a unity, as a crystal is one clear thing. It has definite form and its own structure; so has a diamond or a star. But it has gained other properties which mark a higher kind of individualization. It can maintain itself even in the midst of change. While the matter of it changes, it abides. It can also renew and perpetuate itself. It can reproduce its kind. And, to quote again Professor Shaler's apt phrase, it is educable matter. We may do well to specify and to state more fully some of these distinctive vital properties which seem to individualize living forms of matter.

We enter into one of the most interesting fields of biological investigation, when we study the metabolism, as it is called, or the nutritive and destructive processes of living matter. These are exceedingly complex and involved. A minute bit of grass, or a protozoan, feeds itself, and so by means of other matter, which it takes in and gives out, maintains itself; but when we ask, how?, we are introduced into a series of most intricate phenomena. Moreover, it is a striking fact that each different kind of cell has somehow acquired the power of selecting its own food, and of rejecting or leaving untouched matter which it does not want, or more strictly speaking cannot use for its maintenance of itself. Some epithelial cells, for example, select from the nutrient material around them droplets of fat; every tissue cell in our bodies selects from the common nutrient liquid, the blood, certain substances only for its use.[1] If we seek further to investigate the metabolism of life within the cell, we shall find that distinct, selective changes occur even in that narrow sphere of vital activities. Some substances when taken into the cell, meeting other substances already contained within it, undergo decomposition and recomposition; some of these products are cast out as useless; others remain in the protoplasm of the cell; still others are passed on into the nucleus, and there undergo further transformations, from which again other substances result. We perceive what a complicated process this is — what wheels within wheels are here. Imagine your watch to be reduced to microscopic dimensions, yet its springs, pivots, and wheels all retained and kept in perfect adjustment, — and you may gain thereby some idea of this wonderful cellular mechanism. But still further, and more difficult to conceive, this microscopic watch must be supposed not only to keep true time, but also to oil and repair itself, periodically to wind itself up, to keep itself going, and even more, for its self-maintenance to select whatever it needs for its own repair, and to cast out whatever in its perpetual motion has been used up.

Chemical physiology has succeeded in following and describing to some extent the transformations of matter

[1] Verworn, *opus cit.* 527–528.

in the processes of nutrition; but the authorities differ widely in their guesses concerning the manner and means by which they are brought about. Concerning the fact that certain cells take up only certain substances among all those available (e. g. the seeking of *Spirogyra*-threads by the *Vampyrella Spirogyræ*, or the selection of droplets of fat from the intestinal contents by the epithelium-cells) the neo-vitalist Bunge remarks: "No chemical explanation of these phenomena is conceivable." Yet Verworn maintains that it is mechanically as easy to conceive of such phenomena as it is to understand other chemical changes.[1] Whether or not the investigators may ever succeed in bringing under known chemical relations these marvellous, subtle, and intricate processes of cell-nutrition and change, the point, which we are making, will remain unblunted; it is sharply to be put as follows: this inner, self-selective, and self-maintaining life of the cell marks a new kind of individuality. In whatever way it has come about, its existence denotes a definite gain in nature's movement towards the individual.[2]

This conclusion is further emphasized by the phenomena of reproduction. The mother-cell divides itself, as in a previous chapter has been described, into two daughter-cells. Life thus reproduces itself, life multiplies itself by means of itself. Herein is a new and effectual fact of individuality on the earth. If the

[1] *Opus cit.* 528.

[2] Compare Herbert Spencer's reference to the kinship between his generalizations and Schelling's doctrine that "Life is the tendency to individualism." *Principles of Biology*, vol. i., p. 178. Appleton's ed. 1898.

coming of the crystal was glorious, the advent of self-reproducing life in the cell is a more excellent glory. The *protococcus* and the *protamœba* are small and despised, lowest of vegetable beginnings and humblest of animal forms; a drop of water is sphere enough for their existence; but when these lowliest of the children of life first appeared, they were of greater value than the whole world which sheltered them, and of higher significance than the suns whose rays may have called them forth; for they were heralds of the world to come, and they prophesied a kingdom of life and individuality to which all the kingdoms of the earth shall be made subject.

Through the realm of life the way of individualization, when once it has been gained, runs on with increasing distinctness. As a next step we observe the clear gain of animal intelligence.

This great gain has been achieved in the animal world, this new distinction of individuality has been acquired; viz., the sentient power of using something else for one's self. The lowest animal by its sentient motions renders the vegetable realm subordinate to itself. By that faculty the individual is seen to be coming. Not only in the animal kingdom does life maintain and reproduce itself blindly as it seems to do in the plant world; but this further power has been won by the animal of putting a whole order beneath it and making it serve itself. The animal with discriminating tentacles seizes and uses the vegetal for its own ends. It does this with sentient discrimination.

The different members of a species of animals are not merely so many numbers in a succession, differing only in external shape, or slight measures of line, and shades of color, like the leaves on a bough, or the blossoms of a fruit-tree. The numerals in the animal species are sentient entities; each has some feeling of its own life. In its beginnings indeed, as we noticed in our introductory chapter, animal sentiency may seem scarce distinguishable from the sensitiveness of some plants. Irritability, or the power to receive and to react under stimulation, may be regarded as a primal property of all living matter. But in the animal order this general sensitiveness becomes specialized; this power is carried further, and made more of, and develops, as animal life ascends into that highly organized kind of sensitiveness which we recognize as animal intelligence. So developed, and so marked, it becomes the distinctive property of the individual animal organism. It is animal sentiency as distinguished from vegetal sensitiveness. It is physiologically determined by the nervous system, with its localized centres of reaction from within to stimuli from without. The more developed and pronounced these nervous centres are in any species, the more that species may be said to be individualized. Each member of it has not only the character and habits of the species to maintain, but also its separate motions and life to exhibit. Moved by the stirring of its own life, and the feeling of its value, the bird of prey, or the beast of the field, seeks to maintain its existence in the hot struggle by pursuit or by flight; it is not merely for the sake of the preservation of the species, but for the preservation of itself, that the active struggle of the higher animal is waged. Individuality, indeed, on this higher animal plane has not yet completely emerged from the life of the species; for animal sentiency may still seem to resemble the sensitive motions of plants more nearly than it approaches the feeling of a life conscious of itself and its freedom. Nevertheless nature clearly gives to the higher animals more and more pronounced individual values. Life in the highly organized animal with its powers of self-impelled motion, and also its newly acquired capacity for suffering, lends to the animal much more individual as distinct from specific value. The acquisition of the power to feel pain, be it noticed, is part of the natural cost of higher individuality.

The next step in the process of individuation is marked by the acquisition of personality.

This gain is so immense, and, so far as we have historical knowledge, so abrupt, that it seems to many to have been an entirely new beginning rather than the climax of a whole process of evolution before it. Spirit in our consciousness of its free power is so unlike any other energy in our observation of it, that the two seem incommensurable. To compare the one with the other seems like an attempt to compare a quality with a quantity: we have no common term of measurement between matter and spirit. Henceforth, it is said, after the coming of man, the creation exists in two kinds, the material and the spiritual; and the processes and laws of the one cannot be transferred to the other. But in the first chapter reference was made to the immense momentum of the scientific argument for the genetic unity of nature; it sweeps us from our hold upon the idea of any absolute break in the one continuous nature-process.[1] We can admit scientifically no real dualism in the evolution of the existing universe of persons and things. If personality is eventually found existing anywhere in nature, it must have come there in a natural way. It must have its proper and appointed place and time in the natural order. It is not there as a foreign importation, but as a native and an heir, possessing some relation with, and issuing from, all that is and that has been before it. Even though spirit, as we know it within ourselves, in comparison with matter, appears to be something supernatural, it must have come naturally into its existing relation with the material world. It may be transcendent, it may be supernal; but it is not supra-natural, it is not contrary to nature. Personality, rather, is to be regarded as a specialization of a spiritual element and energy which was in the beginning, and which has ever been pressing to revelation throughout the whole evolution. Personal centres of consciousness are so many points of specialization of the spiritual energy that pervades the universe. Personality is the spiritual star shining clear at last from the spiritual nebula.

We have before us two suppositions with regard to the origin of personality: one is the supposition of its supernatural descent; the other is the supposition of

[1] This article of scientific belief is well stated in these words of Professor Brooks: "All living things are one by birth, and the system of living nature is, historically, a unit, a consistent whole, not a collection of isolated and independent species." *Foundations of Zoology*, p. 123.

its natural ascent. It may be said that upon this latter supposition the dualism is not really escaped, but only put farther back. If that were so, it would still be an advantage not to come suddenly upon the dualism between mind and matter far down in the course of evolution. For if abruptly, and without warning, mind should break in upon an animal body, like a thief in the night, it would be an inexplicable appearance, which would put all our knowledge of nature to confusion. The supposition that mind was thrust suddenly from above down into a material body, would break the course of nature in two in the middle of it. It would have nature begin looking one way, and suddenly face about, and end looking another way. It would render the whole progressive development of animal intelligence abortive; and man would then appear as an afterthought to make good nature's miscarriage. Upon the supposition of his supernatural descent man comes not to fulfil all the law and the prophets of intelligence before him in the animal dispensation, but as a second creative attempt to put mind into a body after one whole course in that direction had proved a failure. We prefer to think of the coming of man as a still further success of the Creator in the one eternal purpose of intelligence.

Moreover (as we shall take occasion to note more particularly in another connection), we shall escape a peril of much practical as well as philosophic and religious consequence, if we do not regard man in his origin as separate from nature: man does not stand apart, having his life in himself to lead — his own person a miracle over which he may congratulate himself; nor in his strange loneliness, as an alien here, need he feel himself unreconciled to nature — he himself set against the world, and the world his enemy. We may learn from the development of individuality, as we follow the long, ascending nature-process through which personality has been gained, that our human life is essentially a life bound to all before it, and to all the world around it; that a self-consciousness, which is not at the same time a natural and a social consciousness, is an aborted and degenerate form of individuality; that a man's life above all other creatures consists in communion, and not isolation, in a felt kinship with nature, a most friendly sense of belonging to the universe in which he dwells, and of oneness with the living God who is his home.

At the beginning of the last century this world was religiously and philosophically regarded too much as a thing apart — as a rounded whole, indeed, complete in itself, but too much like a great ball, which had been rolled together in six days' time, and thrown from the hand of the Almighty out into empty space. The most man had to do with this earth-ball was to condescend to live a little while upon it. Man was looked upon as a being apart, walking in solitary and awful responsibility before his God, like a lone figure seen on a wintry horizon, wrapping his cloak about him, and standing out sharp and clear against the sky-line. The poetry, and the missionary humanitarianism, and the science, likewise, of the nineteenth century have left us with another view of nature and of man. Wordsworth, at the beginning of it, set the poet's heart free from artificialities, and sent our human life back to nature. And many strong and gracious influences have combined to arouse us to noble sense of our oneness with humanity. We know that only in the good of all can our little individual cups be filled with always overflowing blessing. As part and essence of the same higher truth of the perfection of the individual life, not in isolation, but in fellowship, modern science is enabling us more richly to realize our oneness of origin, of endeavor, and of destiny with the whole creation in its earnest expectation as it has waited for us, and still waits with us, for further revealing of the sons of God. The last century's science has left us with a new and invigorating sense of man's belonging to nature, and hence also with a deeper, richer, religious sense of his possible communion with the Spirit of the universe. Nature, as we now know it, is a growth — in some directions, maybe, it is still growing. We consider the lilies of the field, we consider the Pleiades in the sky, how they grow. And man too is one of the first-fruits of the creation. His personality is outgrowth of the ages. It is of measureless worth, because it has been so long in growing; all things hitherto have worked together for its coming. We imagine the first forming of the molecule from the ethereal something; and that molecule takes on significance beyond itself as the elemental beginning of the life which now we may feel as ours. We behold the self-movements of the unicellular organism in the microscopic field; and even that early life becomes sacred as the far possibility of our own. We follow the development of intelligence, of pleasure and of pain, in the higher animal world, and revere it all as the gathering of the energies and the shaping of the forms, the opening of the eye, and the sublimation of the brain, which in the fulness of time shall render possible a "being breathing thoughtful breath," from whom we have our birthright. As we receive our personal share and part in the grand spiritual achievement and joy of all these ages of the Spirit, humbly and with grateful reverence we would learn from their unbroken and sure development this supreme word of life's interpretation, "My Father worketh hitherto and I work."

What then does this poetic feeling from the last century's beginning, and this scientific faith of man's unity with nature at its close, require of our philosophy and our faith? Not denial, nor abridgment; not fear, but comprehension. This oneness of man with nature remains to be taken up into and assimilated with our philosophic conception of personality. Our definition of personality is deficient, if it does not include this truth of its humble origin and its glorious ascent. We shall miss indeed the truth, if we identify personality with anything beneath it; and we shall also miss the truth, if we fail to take up the whole process of nature before it into the idea of personal life and its fulness. To identify the finished individual with the forms and processes by which he has been brought to perfection, would be a needless lapse into materialism; as to identify God with his world would be a sheer descent into pantheism. But to gain any scientific or philosophic conception which may enable us better to perceive how all things consist in God, is not pantheism — it is religion. And to gain some scientific idea of the unity of nature, which may enable us better to perceive how the whole creation is summed up in a Person who is the first-born of every creature, that in all things he might have the pre-eminence, — that is not to lose, but to find our individuality in a richer possession of it, and in its highest revelation in the Son of man. It is possible that the scientific view of the natural history of personality may require some philosophic revision of our conception of personality.[1] But such revision will be a gain rather than a loss; we shall not see less clearly its present freedom and its spiritual distinctness, because we may learn to see more clearly the way through which it has been brought to its pre-eminence. It will be an enlargement and enrichment of the idea of personality, which shall comprehend both the separation of the individual life from the mother's womb, and also the fulfilment of the whole nature-process before it, when there is the joy of the birth of a man-child into the world. From origins most lowly, and by persistence in the straight way of life not to be stayed or turned aside, the distinctive and abiding worth of the free, self-conscious, moral being has been reached. The person most deeply conscious of spiritual distinction feels likewise most truly and joyously his real and abiding unity with all the beautiful world without, with the whole of humanity, and with the living One.[2]

[1] Mr. Morris argues that mental activities may be products of the evolutionary order while they transcend it. *A New Natural Theology*, p. 207.

[2] The Christian theologian may find help from scientific knowledge of the natural history of personality. A far broader natural basis may be gained

To follow these suggestions further would lead us into philosophic fields, and in this argument we must not stray too far from the naturalist's path. Those who wish to pursue the matter in the more philosophical direction will find able guidance, though sometimes rather difficult to follow, in Mr. Ward's recent volumes on *Naturalism* and *Agnosticism*.[1] He has shown with critical mercilessness the contradictions and absurdities into which those thinkers fall who would put matter first, and spirit second, in evolution. The philosophic key to our understanding of the fact of the unity of the world is given in the faith which comes naturally to us in our self-consciousness, that the spiritual has priority in everything. Mind may have lately come to distinct revelation in human personality; but something Intelligent and Spiritual is the Alpha and the Omega of evolution. If we begin all our science and all our philosophy with the simple assumption of the priority of the spiritual, if we assume the spirit to be first and discover its increasing revelation through evolution, we shall not indeed

thereby for the doctrine of the Incarnation. It may be seen to be culmination and fulfilment, not breach and reparation of natural law. The highest Christian revelation in the supernal Person of the Son of God's love may appear as the most natural thing in the world — the only natural end of it. Would not the Apostle Paul have gloried in the knowledge, which thus opens before us, of the "First-born of the creation"? But a suggestion here must suffice.

[1] See also the notes of Mr. Romanes' unwritten book in *Thoughts on Religion*, pp. 127 *sq.* Becoming a theist, he perceived "the possible union of immanence with personality." He proposed "to go much further than any one has hitherto gone in proving the possibility of this union." The theologian may well heed this remark of that Darwinian naturalist: "For no one, even the most orthodox, has as yet learnt this lesson of religion to anything like fulness. God is still grudged His own universe, so to speak, etc."

escape difficulties, nor solve all mysteries; but the difficulties which our thought must meet, will be seen to arise from the limits of our knowledge, and not to lie necessarily in the nature of things; and the mystery which beyond all our science must remain, will be felt gladly by us as a mystery of the infinite light, and not feared as the horror of great darkness. The world as a spiritual evolution is at least rational, if it be not fully comprehensible; the world as mechanical evolution is neither comprehensible, nor rational. If we begin with the spiritual, we know what we know, although we know in part; if we begin with the mechanical, we do not know, and what we think we know, is meaningless. From the naturalist's point of view, without entering too far into the metaphysical, the matter may be put summarily in this way: Taking our start from the assumed priority of the Spirit, and trusting to a principle of intelligent direction throughout nature, we can at least follow one way, keep to the same ascending path, and never need lose the clue in following nature on and on. All the facts which are becoming known concerning sentiency and intelligence in the plant and animal world; all the observations which are being gathered to show the action of intelligence among animals, fall into place, and shall serve to mark out the continuous spiritual course and character of evolution. And the coming of the final distinct and permanent person is not a miracle, but an advent. Personality crowns the whole natural process of individuation; it is the supernal fact towards which the evolution has always been directed.

The naturalist may say, If I cannot define personality, I may accept it. I cannot define life, but I will possess it, and make the most of it. I will dispute no reality which I may know, although my science can know it but in part.

It lies next in the course of our thought to search more thoroughly for the meaning of the advent of personality in nature. How are we to interpret the significance of this supreme fact of human personality, which we have seen to be the summit and glory of nature's long process of individuation? Man's self-conscious life, as we have been insisting, does not lose its spiritual supremacy when it is seen to be the issue of all the energies that have been working together for good throughout the whole nature-process before his coming. The worth of our human personality receives higher valuation when we estimate it by the cost of the ages. Personality becomes more significant when we discover that with the inevitableness of natural law its high calling and spiritual election have been made sure from the foundation of the world. By this conclusion we are prepared to find further meanings in the coming of personal life as an event in evolution. As other, lesser events before it have indicated, only more conspicuously, it shows that the spiritual energy in evolution has power to keep on from one order to a higher order. Nature does not break with itself while it rises above itself. Time and time again the crisis has come when nature must go forward to something better, or else fall back beneath itself. And the crisis never yet has proved to be too much for the inner spiritual energy of the universe. This would not be so, were nature only so much mechanics. For a mere machine cannot meet a crisis and rise above it. But nature does. A machine can never transcend itself. But nature passes the critical point, and goes on. The Spirit which is in nature gathers itself up, as it were, and presses on towards the goal.

It is true that at the end of one order evolution seems at times to take a great step forwards; but the leap is never made aimlessly in the dark. Nor is the new order too distant to be reached from the old. But there is an advance, and the new is better than the old. The early step from the physical order to the protoplasmic order — that step which was first taken we know not when or where — was not too long for the spiritual energy of nature to traverse; nor was the rise from the highest animal intelligence to the lowest human intelligence — great as that distance may seem to be — too difficult for the same Spirit to compass it. The living God, we may believe, has nowhere broken with his own thought. He has fulfilled himself in evolution. Personality is significant as fulfilment of the Divine in nature.

We may discern in several particulars this meaning of the arrival of personality as an event in evolution. Two noteworthy signs in man's coming are to be pointed out. One is given in this fact: when man is reached, there appears to be an arrest of evolution in one direction, followed by an opening for life in a new direction. The body stops; the mind goes on. Physiological development is stayed; a new way of mental development is opened. In the human body the long-continued process of sharpening the senses and of refining the instincts is brought to an end. Animal sentiency becomes secondary and tributary to self-consciousness. Life consciously determined takes the place largely of instinctive action. We may observe in ourselves the evidence both of the conservation, and also the subordination of animal sentiency. For, on the one hand, sensitiveness is kept at its height in our nervous organization. The human brain as a central organ, together with the nervous system connected with it, is the finished mechanism of sensation, — the finest, the most subtle and most spiritually responsive which nature has been able to produce on the plane of animal sentiency. Taken as a whole it is the perfection of sensation. In particular senses some lower animals, it is true, may surpass man's sentient power: the eagle in its airy circling has sharper keenness of eye; the deer on the alert in the forest possesses more subtle scent, and will escape us; even the insects among the flowers have optic ganglia so curiously connected with the facets of their compound eyes that quite possibly they may see some things which our eyes cannot perceive.[1] When, however, we consider sentiency as a whole, and in its varied adaptation to environment, we may conclude that in the human body sentiency has apparently reached an ultimate degree of physiological perfectness. In some ways still it may be enhanced, but in form it is finished.

There is indeed no sign of any further development

[1] Wallace, *Natural Selection*, p. 92.

of mere body beyond our present embodiment. Nature gives no promise of any higher and finer arrangement of molecules for sentient life than is now found in the intricate structure of the brain of man. The extent to which organization of atomic matter for the use of intelligence has been brought in the convolutions of the brain, is a wonder passing knowledge. It would seem that matter more ethereal must be used, if embodiment for the use of the spirit is to be carried any higher. There is no hint anywhere of the future coming of any body of the earth earthy, which shall be constituted from atomic matter of cells endowed with subtler elements, woven into more delicate nerve patterns, and serving as an organ still more marvellously subjected to the processes of the intellectual life. So far as our observation extends, nature has reached her ultimate of molecular organization for spiritual uses in the human body.

This conclusion is rendered more evident by the further fact that in some particulars sensation has already dropped back and become less refined in man's body than in some animals. For such arrest and even slight retrogression in the senses of man, indicate that an acme of sensation has been attained in his nervous system, and that no step further is to be taken in this direction. Another step, even a short one, might require not the further development of this body, but the advent of a new type of embodiment.

The arrest of physiological development and need of some new order of body for mind, if evolution is to continue beyond man's present estate, will appear clearly when we compare the part played by instinct in the higher animals with the use of instinct to man. The effort of the individual to maintain its own life culminates in animal instinct. Instinct has become keenly sharpened as a weapon for protection in the animal world. But in man, while instinct remains as an animal achievement, it plays, almost from infancy, a subordinate rôle. It is not our chief dependence for self-preservation. Man in some respects has dulled the fine edge of instinct to which nature has brought animal sentiency. But the loss is for a gain. The loss of animal instinct is less in the lower, savage races than in the more intelligent types of humanity. The gain in the latter is the result of the overshadowing of a lower kind of self-existence by a higher kind: instinct decreases only as reason increases. It falls into disuse because something else has come in for better use.

These facts suggest the further prophetic meaning of the advent of personal life. Through personality and its possible development a new way of evolution has been opened. The arrest of the body is an announcement of the birth of the soul; — and that is to grow after its kind.

Another fact of large interpretative significance deserves in this connection far more attention than it has as yet received. It is a note of evolution of great moment that in the coming of man a point is reached where the individual begins to exist for his own sake, and no longer chiefly for the sake of the species. This is a critical point, — to pass it, is a gain immeasurable. At last the value of the species culminates in the worth of the individual. Man, the species, exists for man the individual person.

The course of individuation, which we have sketched, results at length in a change of values. At first, and for a long time, the individual life was possessed of value because it was adapted to the task of preserving the species. At any cost to the swarming myriads of organisms the species must be maintained and perfected, and the way prepared for still better species. Now there is no other or higher species than the human race to come, and the individual man asserts the worth of his life to himself. It will prove profitable for us to examine this truth more closely.

Among the lowest organisms the struggle of life is visibly for the success of the species. The germ-plasm survives. It is life in general, not the individual, which is deathless. Nature's first interest seems to be solely to fashion and to maintain the species, and it sacrifices myriads of individuals that the species may be preserved. Multitudes of individual organisms perish almost as quickly as they spring up. Many exist just long enough to reproduce themselves. The Mayflies, for instance, live for a brief nuptial flight in the sunshine, and die in the very effort of maintaining their kind. Alternate generations occur, the species being thus kept alive through different forms which perish. The life-circle remains unbroken, while the organisms which complete it pass away. Some adults, like the *Yucca* moth, will make curious provision for the future preservation of offspring which shall exist in a form and manner totally unlike the parent organism, and of which the parental moth can have had no experience. It never sees its own offspring, and would not recognize them if it did. So the parents toil and spin and perish for the benefit of a posterity they know not of. So the species, not the individual life, is nature's first care — the object through age-long cycles of her unwearying pursuit. One of the most general impressions of observers of the life which flits through the air, blooms in the meadows, and teems in the waters, is this, that the individual counts for nothing, and that thought for the species is all that nature has at heart. What our older theologian, Jonathan Edwards, regarded as the essence of virtue seems thus in a sense to be nature's earliest characteristic, viz., "the love of being in general." Nature at first seems not to be mindful of being in the particular.

From this observation of the universal primacy which nature seems to give to the species, and her recklessness of the individual, we are apt to carry over to the estimate of our own existence the thought that with us likewise the same law holds, and the same strenuous process must be continued, so that the individual man can be possessed of no distinctive value in himself, but must live and die, as have all forms of life before him, simply that his race may be preserved, and humanity survive, while the individual perishes forever. But is this inference from the world below us, as to the value of our life, correct? Because the individual counts seemingly for nothing below the plane of personal life, is it true on our plane that the species is the main thing, and the individual the least concern of nature? At this point a principle which we have already expounded comes again to guide our reasoning, — we refer to the law of vital values. Each successive stage of life has its own vital value. One feature may be of more value to life on one stage of evolution; another character may be the thing of worth on a higher plane. The question at every point of the way is, what at that point is the thing of most value? It is possible, therefore, that as the evolution proceeds, something which heretofore had not played an important part, or been of prime value to life, may rise to the place of supreme worth, and become the one law to which nature will keep with all her strength. It would not be surprising, therefore, if, when the higher plane of personality is reached, the individual should acquire a value never before known in nature. It would not be a breach of continuity, if it should appear that the law, which before had held good, of the existence of the individual for the sake of the species, should meet with some modification, or become subordinate to some higher valuation with the advent of man. If so, it would be probable also that the new valuation put at this stage of evolution on the individual, would be seen to be the culmination of a worth which had been growing, unsuspected and unperceived, perhaps, through the whole previous course of nature. It would be revelation of a thought of worth which all the while had been hidden in nature's heart. Is it so? Are there any facts which indicate that beneath nature's manifest care for the species she has had from the beginning a deeper passion, and that all the while, although she has not told it, the individual and his noble worth has been the secret of all her thoughts?

For the answer we look again, and with more eager searching, into the facts of life. We may notice multiplying signs, as life ascends, of the relative increase of value given to the individual in comparison with the preservation of the species. Such signs are these. There is an increasing limitation of the number of the individuals which are necessary to maintain the species. More play in the preservation of the species is given to the individual life. More use of individuality is made for the species. Compare, for example, the immense number of the eggs of fishes or of insects, which are required for the preservation of the species, with the smaller number of eggs of the birds and the higher mammals. Weismann has noticed the fact that the golden eagle lays but one or two eggs, while at the same time nature has made careful provision for the protection of one or two eaglets only, and trusts to this provision for the preservation of the family of golden eagles; that is, nature begins to trust to numbers far less, and to individuality far more. Her method of maintaining the species has thus been quietly changed from that of prodigality of birth to careful nurture of a few offspring. Limitation, instead of prodigality, is the new sign of nature's advancing individuation. The species is continued, no longer through the swarming of the many, but by the election of the few. The way of natural providence ceases to resemble the thoughtlessness of the spendthrift, and becomes the method of the caretaker. Nature takes no longer the chance that a few of the multitudinous seed may escape destruction, but she trusts to the power of the carefully selected few to maintain themselves in the struggle of existence. Nature, in short, prizes the individual more highly, and uses him more and more in evolution. And this change also is a prophetic sign.

Added to this fact is the further circumstance that in the higher animals the life of the individual is prolonged after it has ceased to be of value simply for the sake of reproducing its like. The natural limitation of life among the lower creatures seems to be determined directly by reference to its reproductive function. When that has been fulfilled the individual dies. Nature has no further use for it, and it perishes. But this relation between the duration of life and its reproductive power changes in the higher forms; new factors enter in; maternity ceases to be fatal. Motherhood takes on happier worth; it may continue long as the blessing of a human home.

In this connection due estimate should be made of that remarkable aspect of evolution which it is Mr. John Fiske's distinction to have pointed out and emphasized; viz., the prolongation of the period of infancy among the higher animals, and its especial significance and beauty in our human homes. By all these signs nature shows her increasing valuation of the individual. For him and for his happiness she has toiled and spun. For him and his personal life she has sacrificed all. For the mother and the child, for the man and woman living for long years of love and joy, all her ages have been given, all her work has been done. The individual in his perfectness is the end of all nature's ways. For him has been the love kept secret in nature's heart from the beginning of days.

We may sum up biologically this matter as follows.

Its importance justifies some repetition. We grant the apparent truth that the individual at first sight seems to have been made for the species; that adaptations of the individual organism have been naturally selected in relation to their species-maintaining value; that the individual perishes in order that the species may be preserved, and that the individual may even be helped to perish by the very adaptations which serve for the better preservation of the species. But, on the other hand, there are certain aspects of evolution, less noticeable at the first, yet more and more revealed as life advances, which show the coming value of the individual. The individual seems steadily to gain in importance in comparison with the species. Suppose that at length in this increasing worth of the individual a point of equilibrium is reached where nature's two interests in life become evenly balanced, and the individual equally with the species has vital value. What then? The process certainly could not stop there; nature never rests at any point of equilibrium; nature is certainly not a machine which can be stalled on a dead centre. Should these two interests, that of the species and that of the individual, become equally balanced, then two courses are left open: either one or the other must become predominant and determinative in the process of natural selection; either nature must return to a reassertion of the original necessity that species is the one thing to be preserved, or else press on to the higher assertion of the supreme worth of the individual. In the latter case, the natural logic of the movement onward to the highest vital value may require eventually the subordination even of the reproduction of the race to the immortality of the individual persons. If this be so, we might expect further to discover some tendency in evolution to render the powers which regenerate the species subordinate to the powers which regenerate the man.

As another consequence there would be involved naturally the limitation of the numbers of the individuals who in their succession constitute a race, and the survival or immortality of the individuals who had attained life in the highest: after the race might have ceased to be maintained by its propagation through successive generations, it would survive through the continuance in existence of the individuals which it had produced. And in proportion as we may find reason to suppose that this is the actual culmination in the life of man, and its abiding worth, we may draw from these considerations a natural presumption for the continuance of man's personal life in some further adaptations to the conditions of his existence beyond our knowledge. To this trend of the argument we shall return later on.

We remark in passing that at least in view of these facts and half-disclosed tendencies of evolution, we can no longer draw, as has so often been done, an argument against the future continuance of the individual life from nature's seemingly relentless care only for the species. For the survival-value of the individual becomes in time the chief value. To the life of the individual natural selection itself is put finally under bonds. The final question therefore, which is raised by this whole process of individuation up to its natural climax in man's self-conscious personality, may be put after this manner: Has not at last in man's life a point of equilibrium between the vital value of the species and the worth of the individual life been reached and passed? Has not life the most at stake now in the continuance of personality? Has the individual life gained at last a supreme spiritual worth? Is it so at last, that to proceed further, to complete all before, and to go on, this one thing evolution must do, — press toward the goal of the immortal individual life? The one thing that remains, — all beneath having been accomplished, — is it not for the living person to gain perfect adaptation to eternal life? Henceforth in the new order, which shall be fulfilment of all, shall man the species cease to be multiplied on the earth, and man the spiritual individual live immortal? Does the evolution as a whole, we are questioning, point that way? We are assured in the Christian revelation that the children of the resurrection shall neither marry nor be given in marriage, but they shall be as the angels of God. That is, in the resurrection-life man the species has died; man the individual lives on. Sex, through which life became rich and fair, shall no more be needed for the sake of life; — they shall no more marry, but men and women, the children of marriage, shall be as the angels. Through the death of the human species shall be gained, as the consummation of all, the immortality of the individuals. They who are accounted worthy of that world — in whom life has reached such survival worth — are equal to the angels, and are the sons of God.[1]

[1] Luke xx. 36. In relation to the origin and the end of sex in evolution see the author's *Place of Death in Evolution*, pp. 24, 133–135. It would

Before we may approach any nearer from the naturalist's side to the hope thus suggested, some other questions which meet us at this point must be resolved, and some further principles of spiritual direction in nature need to be elucidated.

seem unnecessary to remark, if some critics had not mistaken the point, that it is not supposed that the products of sex, the distinctions between men and women, are to be lost according to this conception of future social immortality; but only that sex itself, the means of the diversification and enrichment of life, is to disappear when its work in evolution is done.

CHAPTER IX

RETROGRESSION IN EVOLUTION

One of the questions which confront our hope of better life for man, is raised by the unmistakable fact of retrogression in nature. The process of individualization, which has reached so high a plane in our personal life, leaves open at every step of it the possibility of a fall. On any height of life thus far attained, a fall from life is possible. Can we hope to gain for the individual life some height at last from which no fall may be possible? Or shall descent even into the depths be the last end of evolution? After the whole struggle and the supreme achievement of personal being and joy, shall death, not life, prove to be the final law? What, if any, are the facts touching this issue of greatest concern to man, and may we read them in any interpretative light?

Retrogression is certainly a fact in evolution. At times in nature's progress there has been some slipping backwards of the wheels. From life's straight and narrow way there have been all along deviations on either side. Nor has the path of life been uniformly an ascending one. Some loss, at times seemingly cruel loss, is to be seen on the field of life. Even under normal conditions metabolism, as it is called, or the series of changes always going on in the nutrition of an organism, is both constructive and destructive, an up-building and a pulling down. Under unfavorable conditions a species may lose the foothold which it had already gained, and perish. Degeneration is a familiar fact. De-evolution is always possible in the cycles of endless change. Higher forms will lapse into lower; vital products may break down; the crystal can be ground to powder; the elements may be dissolved with fervent heat. A descent of man — his fall from his high estate — is not outside the natural possibilities. Anywhere along life's way, even at its highest, death may be met coming naturally there, and not appearing suddenly as a supernatural enemy. But is the entrance of death a defeat of life? Is retrogression a passing phase, or final tendency of evolution? Is the fall a temporary incident, or a necessary and irretrievable loss of life? Furthermore, where retrogression and descent may be observed, is there also on closer scrutiny to be discerned any principle of restoration in nature? Can any principle of life be discovered by means of which evil shall be held within limits, and finally be overcome of good?

We can only judge of what is unavoidable or necessary in nature from the actual course of events. From that which nature has done we must learn what can be done. As matter of fact we observe that variation — the life-enriching potency of nature, — itself involves the possibility of retrogressions. Variations which are not fitted to survive have occurred, and been rejected. Some oscillation of life below as well as above the mean, results from the same principle of variation which is nature's chosen method of advance.

A scientific generalization, which is known as Galton's law, is here to the point; it has been called "the law of filial regression." Galton demonstrated through much research a law of averages in evolution, or a tendency in natural variation to return to the mean; as, for instance, the children of very tall parents are not always so tall, and the children of small parents not so short as their fathers and mothers; and a similar tendency towards the average prevails with regard to the intellectual stature, the children of genius are not so remarkable, and fortunately the children even of matched stupidity may not be so dull as their parents.[1] We may observe a similar tendency towards the mean in the moral sphere; are we not all apt to be quite content with keeping our conduct up to the average standards of social propriety, civic virtues, and even religious customs? In view of this natural tendency towards the mean between extremes of development, it is evident that progress is to be gained and secured, if at all, by leveling the whole mass up. Among the conditions of progressive evolution, this give and play of life backwards and forwards, above and below the average, seems to be necessary. The bearings of nature's wheel are never screwed too tight to permit of some oscillation, so that it may go. Some deterioration seems to be an incidental expense as part of the cost of progress.

The possibility of retrogression, which is involved in any progressive evolution, is not lessened, rather it

[1] Galton, *Natural Inheritance: Hereditary Genius.*

grows greater and more ominous, the higher up life may succeed in climbing. And degeneracy becomes more marked and more repulsive the more finely organized the forms in which it appears. In the more complex and more vitally valuable organisms there may ensue a process of degeneracy, which shall involve more extensive and disastrous evil in proportion to the worth of the organization in which decay has started.

A single isolated cell may be maltreated by a biologist, and, if he gives some poison to it, certain degenerative changes in its protoplasm will soon follow, or its activities may be entirely destroyed. If the cell exists not for itself alone, but as a part of some tissue, then, besides its loss of its normal activities, other and more extended consequences follow; other cells will suffer with it; the tissue of which it is a part becomes affected, and may cease entirely to fulfil its function in the body which it serves. Then the whole body may perish. The individual cells of a cancerous growth, for instance, are known to multiply abnormally; they will form several figures of division at once, thus showing signs of rapid degeneracy; and as a result the entire tissue in which they grow speedily degenerates, and death ensues. So degeneracy increases in extent and complexity with organization. The evil of it becomes greater with advancing individualization.

Not only does this hold true when we consider, as we have just been doing, the phenomena of disease, but also when we observe the course of retrogressive evolution, which may occur when a species is subjected to unfavorable conditions for its self-maintenance at the height of its development. Acquired powers may be forfeited by long-continued disuse; under unfavorable conditions organs may become atrophied, and descendants may be dwarfed, or otherwise set back on the scale of life when compared with their parental or related forms. A single chapter of natural history is enough for illustration, — it might be entitled a chapter concerning the ways in which eyes are lost. We select two or three instances from it. There is a relative of the well known lobster, by name *Eryonicus*, whose residence is at the depth of 825 yards in the ocean. There is not much light at that depth where *Eryonicus* lives. Accordingly he has dispensed with the well developed optical apparatus which his relative, our friend the lobster, finds useful where he lives at a less and better-lighted depth. In *Eryonicus* the optic stalk has been reduced, and at its extremity, where in kindred littoral forms the eye is borne, there remains only a depression, "as if the eye had been carefully scooped out."[1] Another member of the crustacean family, *Scolophthalmus* by name, which lives down at a depth of 4000 yards, possesses still an eye-stalk which ends in spines, but it is devoid of eyes. There is one species which is interesting because in itself it "exhibits all grades of degradation according to the depth at which it lives. This creature — *Cymonomus* — which, when near the surface, has fully formed eyes upon movable stalks, at a depth of a few hundred yards exhibits movable stalks without eyes; and at 1500 yards the stalks are fixed and end in spines."[2] We might add that this illustrates the manner also in which men may lose

[1] *Evolution by Atrophy*, Int. Scien. Ser., p. 188. [2] *Ibid.*, p. 190.

their eyes — their power of moral and spiritual vision — according to the depths at which they habitually live.

Moreover, natural history records numerous instances of retrogressive evolution under too favorable conditions of existence, as in the life history of some parasites. A barnacle has degenerated from a free swimming form. One little creature which has, to begin with, three pairs of legs and an eye, when it settles down to comfortable existence on a crab, which is its host, —when, as it were, it becomes content to hang its hat on its father-in-law's hat-tree, — loses after a while its eye and its legs, and becomes a mere absorbent nutritive sac.

Without describing other examples of organic degeneracy from entering what has been called the "vicious circle of parasitism," we would call attention especially to the fact that the possibility of degeneracy bears direct proportion to the amount of life which has been acquired. A special sense, like the eye, represents a long and arduous achievement of nature; but that, as we have just stated, may be lost through retrogressive life. The possibility of loss, of fall, of death, may be said in general to grow greater, as the process of individuation is carried further and higher. The possibility of fall will therefore be greatest upon the highest plane of personality. From the spiritual height of humanity the fall has been the deepest and the darkest. There is no creature so fallen as a man who bears on his face the mark of the beast. Perversion of self-conscious intelligence marks the limit of degeneracy which, as we have seen, is incidental to evolution. The sin of the world reaches an extreme of natural reversion from the type; — it is loss of the divine image, which is man's birthright.

In this connection the question arises, how is death to be regarded in relation to the fall of man? The naturalist sees that death entered into the world for the sake of life, and that throughout the course of evolution death has been a minister of the dispensation of life. It is not a sign or consequence of degeneracy, but a means rather of the rejuvenescence and enrichment of life. The biblical theologian perceives that death has acquired in man's history a moral adaptation and use over and above its original natural function. It has become also a minister of the dispensation of moral life; it has an acquired use in the moral order as a means of probation. The *fear* of death is a mark of human degeneracy — a punitive consequence of man's sin.[1]

Reversion in nature before the plane of free personal life had been reached, was without moral character. We may regard it as accidental, if by accidental we mean simply that one or another of several possibilities in nature has become actual. There is no responsibility in the germ for itself, if a seed fails of fructification; there is no wrong done, if an organ is stunted or malformed under the conditions of its environment. When Hertwig pressed apart portions of frog's eggs which naturally go together, and under the pressure of glass plates produced imperfect or diminutive embryos,

[1] We pass by this important topic with a word, because it has been discussed in the author's *Place of Death in Evolution*, see particularly chap. i., on *The Entrance and Use of Death in Nature;* and chap. v. on *The Biological and the Biblical View of Death.* See also Jones, *The Ascent Through Christ*, pp. 168–185.

the responsibility for such failures of typical development was certainly not in the frogs, whatever may be said of the responsibility of the biologist whose intelligent manipulation produced those unfair conditions and predetermined those unnatural frogs. Similarly in the process of individuation, up to man's conscience, at least, if there be any moral responsibility, it is to be located, not within the evolution itself, but without the evolution. It belongs to the prior and predetermining Intelligence, which discloses its own character as the evolution takes form, and moves on towards its issues. Up to man, responsibility for evolution lies outside the process of evolution; with the advent of man responsibility enters into the evolution. The original responsibility for nature is the divine responsibility, if there is a God. But in man's moral life evolution takes on a new quality; it becomes also a self-responsible evolution. The primal responsibility of the Author of it does not cease; but a secondary responsibility of the creature begins. At the point of free-spiritual life, the Creator shares responsibility with the creation. And the creature receives self-obligation from the Creator. Man not only is made, he becomes a maker. Man through his living makes his own soul, or he unmakes it. So our human life is represented by the Christ as an endurance through which we win soul, — "In your patience," he said, "ye shall win your souls." In the spiritual order, soul is to be acquired from life — it is something for us to win. Or soul may be lost out of our lives.[1]

[1] The scientific evidence of the statement above that responsibilty for evolution has entered with man into the evolution, is to be found in the

If we approach in this natural way the fact of retrogression in the life of man, we shall find a very simple answer to the difficulty with which over anxious theologians would put a stop to any evolutionary science with their doctrine of man's fall. How, they ask, can evolution account for the fall? Very naturally, and also very profoundly, we answer. The most awful doctrine of the possibility of fall is opened by an evolutionary philosophy. It is possibility of fall down the whole ascent of life. There may be fearful descent from nature's spiritual height. The degeneracy of man may be moral as well as physical; for at the height of evolution where man stands, and from which he may fall, a self-responsible life has been gained.

This evolutionary doctrine of man's fall escapes, however, the consequence that it must be necessarily a failure of the evolution itself. It does not follow, though man falls, that all is lost. It does not follow from any degeneracy of human sin that evolution as a whole may not prove to be beneficent. For, as may be seen in many instances, an individual organism may fail of vital adaptation to its environment, and be cast aside, while the evolution of life goes successfully on. A variety may survive for a season, and then be found wanting; species may follow species across the field of life, and disappear; but the evolution is not thereby

facts which show man's influence in changing the natural course of events. Man lives and works, not merely as a product of evolution, but as himself a factor of evolution. His action modifies to some extent the course of nature beneath him; and, within limits, he determines the direction of his own evolution. The law of natural selection is modified by the higher law of conscious choice.

frustrated. All the while it may be marching on through defeats to triumph. Within the elastic but infrustrable lines of the existing order, as in a beneficent network of divine decrees, under the beneficent law of the universe as one good whole, our free personality has its sphere, finds room for its action, and meets with limits and bounds also to its possible fall and evil.

Moreover, it is thus seen to be but a superficial view to regard man's fall as a fall upwards. It is in itself considered a descent, nothing but a descent, and never an ascent. No retrogression taken by itself can be regarded as a step forwards. Man's fall is a fall away from his true type. Sin is a plunge downwards, and into darkest depths.

But while it is man's fall downwards, at the same time it is never a fall *out of* the evolution; it is included in the vast beneficence of the whole process of life. Retrogression is provided for in the evolution; a falling away is not a falling out of the scope and compass of the evolution. In itself a defeat, in itself man's sin, it may nevertheless as a part of the whole, and as a moment of life, serve other purpose and confirm in its results life's eventual victory. The advance is made not by means of the fall, as mere naturalism might say; neither is it made in spite of the fall, as sheer supernaturalism might declare; the advance is made by the evolution which moves on through the fall and beyond it, as was determined even from the foundation of the world. The one divine movement, within which scope has been allowed for the play of life and the exercise of human freedom, carries all along with it to its infrustrable goal. It carries man's fall on to its triumph of creative and redeeming love. There is nothing unnatural or inconceivable in this. Man may rush with all speed towards the west, while the great world, swinging on its axis, quietly carries him eastward into the dawn. Man by his own motion cannot escape the rising sun. So the movement of evolution, the divine movement of it as a whole, shall bear man's personal history of sin on with it to the coming day of the Lord.

We have been careful to make these distinctions in order that no vague moral indifference may be thrown over the familiar facts of human degeneracy. For the individual, under any true and wholesome evolutionary conception, sin is still hateful; but for our human hope and trust, under an evolutionary conception large enough to comprehend the forces of redemption, even the sin of the world may be regarded, to apply a characteristic German phrase, as an overcome standpoint.

One other aspect of degeneration in nature should be noticed in this connection; for it suggests some possible ulterior use for the outlying spiritual universe of man's history of sin upon this earth. We refer to the highly interesting fact, which has often been noticed by naturalists, that retrogression in nature may serve to introduce a new variety, and thereby promote some further development of life. Moreover, the reduction or loss of some parts of an organism may result in the higher development of others and the perfection of the organism as a whole. Now the spiritual universe is to be conceived as one moral whole. We are to think of it as an organic unity. According to the Scriptures the spiritual universe is one moral order. The analogy which may be drawn from natural degeneration, suggests, therefore, that there may be ulterior reactions for good upon the whole moral universe from the moral history of this world. It was an apostle who spoke of himself in deadly trial as made "a spectacle to the world, both to angels and to men." (1 Cor. iv. 9.) We do not yet know the further and larger organic relations of man's life to the entire spiritual universe. There may lie in the remoter consequences of human sin and suffering a vaster beneficence than we may know.

The further vital inquiry into which the course of our argument now directly runs, relates to the restorative energy of evolution. This also shall be for us first a question of fact: Does evolution, taken as a whole, tend towards the removal of degeneracy? Are decay and death in evolution's larger use rendered serviceable to life? And if working through nature there is to be discovered hint or sign of any principle of restoration, may that same principle be completed in some still diviner method of human redemption? Still further is it possible scientifically to imagine that through man's life of moral reversion as a finally eliminated variation, some vaster good may be gained, and for the whole spiritual universe? Such inquiries belong to the next chapter.

CHAPTER X

RESTORATION IN EVOLUTION

We shall search first over the lower plane of animal life for signs of the working of any restorative energies, which may throw light upon the character and ultimate tendencies of evolution.

We observe at the very beginning a certain conservative power in the germ — its inherent tendency to hold itself true to its type. An original and persistent conservatism resides in the fidelity of every germ or seed to its specific character. A primal restorative tendency in living nature appears in the constitutional reluctance at least of the germinal matter to transmit bodily mutilations.

We are aware that we touch here upon one of the most controverted points of modern biology. It has been a much disputed question whether either virtues or defects, which are acquired by parents during their lifetime, can be directly transmitted to their offspring. For the sake of clearness, and because of its importance in this connection, we would state definitely this problem to which we have previously referred.

In every animal body above the *protozoa*, two kinds of cells exist, — the germ cells, through which life is reproduced, and the somatic cells, by means of which the body is built up. These two kinds of cells are discriminated by nature very early in the life-history of the egg. Now the question concerning acquired bodily characteristics in the last analysis of it is simply this: Can modifications which have been received by an animal during its lifetime in its body-cells, be given over directly to the germ cells, and through them inherited by its offspring? That is a still mooted question. One school of biologists maintain that it is and can be done; the other school strenuously deny the fact of any such direct transmission of acquired bodily characters. Those who affirm it are known as the Neo-Lamarckians; those who deny it as the Neo-Darwinians. The evidence is conflicting and as yet unsatisfactory.

Bodily modifications acquired by a parent are certainly not taken up easily and at once into the germ-plasm and transmitted to a descendant. We cannot by our virtues or our vices directly and certainly either make or spoil our children. It is well that we cannot. The continuous germ-plasm of life resents direct interference. It tends to restore in the offspring in its natural integrity the life which may have been mutilated in the parental form. The germinal matter is tenacious of its own vital determination. It maintains with much persistence its specific and its individual characters, although possibly under some conditions it may be poisoned or tainted. We are clearly within the limits of ascertained science when we hold that nature in its germs shows a conservative and self-restorative tendency. At the primal sources of life any mutilating or degenerating influences are resisted by the germinal tendency to remain true to the type. Variation indeed is permitted and carefully provided for in fertilization; sex enters early into nature for life's rejuvenescence and diversification: but in the fertilized seed or egg of plants or animals, variation, which is necessary for the enrichment of life, is speedily checked and firmly held within bounds by heredity. Nature is thus conservative as well as progressive from the start. She is both at once, and within the same little germinal dot of protoplasm.

We notice still further that a conservative tendency, which is thus seen to be inherent within the germ, characterizes the organism as one whole; and that, pervading every part, it acts as a restorative check and balance whenever variation in any direction threatens the existence of a species. Without raising just now the strictly biological issue whether this energy resides in the organism as an inherent force of growth,[1] or whether it is the resultant of all the inner and outward influences which act upon an organism, and which are expressed in its form; our immediate insistence is that as matter of fact some check and wholesome virtue works in the life-history of every creature against excessive or hurtful variation. In some way, not easily understood by our science, a plant or an animal body exerts a restraining and even a corrective influence over its parts and members, to prevent undue development or variation in any one direction to its too great prejudice as one living thing. Our biologists are now recognizing among the factors of evolution to be dealt with this vital influence of the whole over the growing parts.

[1] The *bathmism*, "growth-force," of Cope.

Under the influence of natural selection, and through the co-ordination of all the parts, growth too rapid or too extreme on this side or on that, in this member or another, is controlled. Life, moving this way or that, too far or too fast, is pulled back, and sent forward in the one straight way; the balance is finely kept, as is best for the organism as a whole. Symmetry — itself a marvellous factor in evolution — is one of nature's first laws. But more than this remains to be noticed.

It is further to be observed that organic matter within certain limits possesses a self-regenerative power. In many instances a lost part of a body may be restored, or from a single surviving part an entire body may be made anew. The phenomena of regeneration among plants and animals are so well known that we need only briefly summarize them. It is a matter of common observation that a shell-fish may lose a claw, or a lizard its tail, and the loss be made good. The skilled gardener takes advantage of this self-regenerative power, when by means of slips and cuttings he increases his stock for the market. "Cultivators of bath sponges bed out little fragments to keep up a convenient supply."[1] The Abbé Trembley, in the eighteenth century, performed experiments upon Hydras, which furnish the classical illustration of natural regeneration. He pleased his friends, and troubled the Church, by showing how a part of a polyp can create itself anew into a whole polyp. If a Hydra be cut in two across the middle, or divided longitudinally, from the halves two perfect Hydras may be formed.

[1] Geddes and Thomson, *Evolution of Sex*, p. 188, ed. 1895.

Of this regenerative power of nature it may be said that it seems to belong originally to organic matter, and that it is allied to the powers and processes of growth in general. Living matter to a certain extent is self-recuperative under the same conditions in which it may live and grow at all. Regeneration, like growth, is a primal virtue of organic matter. The cells of a tissue or organ at points of casual wounds possess not only their specific properties, but also the characters of the whole body, so that they can become buds from which a lost part may be reproduced, or a new organism be formed.[1]

This regenerative power, however, as we have been careful to say, is a limited one. It is far from being co-extensive with evolution. It diminishes as specialization of parts increases. It disappears entirely from the most developed organs of the body. There is little of it enough left, we may think, in our anatomy. We may sometimes wonder why we do not possess more of this power of self-repair, which the lower creatures seem to have in such abundance. They can restore their own heads when they are cut off. But with us only Christian Science, so-called, might think a lost head on again. Even that fondly assumed independence of matter might seem slightly physiological, if man had left so much as a worm's power of self-renewal, and by taking thought of his stature could add to it. Dentistry might be a need-

[1] Hertwig, *The Biological Problem of To-day*, p. 48. Weismann's view that regeneration is acquired through natural selection is interesting, but it is neglected above, as the manner of the origin of this regenerative power does not affect the interpretation which we are making of the fact of it.

less art, if we had not lost in our development the power of making over our own bones. It is only a remnant of nature's original restorative virtue which the highest animal organization retains. But the original tendency is significant. It is indicative of the first intention of nature, that it is in its beginnings restorative as well as creative.

Another interesting class of facts come under our observation, which serve to illustrate also a certain substitutional power in nature. It is the power to make one part take the place of, or to do the work of some other part for the life of the organism. This power may be observed in several related yet distinct manifestations of its vitality. One of these is illustrated in the remarkable feat which a *Titon* larva performs when, having lost its sight, it reproduces from an adjacent epithelial cell the lens of its own eye. Thus it takes a cell which had its proper natural use, and from it makes a cell adapted to a wholly different function. It substitutes in its economy for the sake of vision one part, or the transformation of one part, for another lost part.[1] To give another example, if a cut be made in a sea-rose, and the fissure be kept open, in a little while, from the surrounding cells, a new mouth will be reproduced with a row of tentacles around it.

[1] Much interest has recently been excited in biological circles over this reproduction of the lens in some organisms. Wolff regards it as an extremely teleological adaptation; — the cell is transformed into a lens for the purpose of sight. A. Fischel, on the contrary, seeks to account for it mechanically as a "topographical" process; — the adaptations take place under the influence of the surrounding parts. See a summary of the discussion in *Virchow's Jahresbericht ueber die Leistungen*, etc., 1901, Bd. i. Ab. i. ss. 83–86. Also, Morgan, T. H., *Regeneration*, p. 203.

In a somewhat different way this substitutionary power of nature finds illustration in the manner in which one organ may take upon itself the functions of another injured organ. Or one part of an organ may be enabled to do the work of another part besides its own task. For example, the pathologists inform us that if one kidney is removed, the other becomes enlarged, and it will attempt to do the work of two. So also when portions of the liver are extirpated, the remaining part begins a compensative growth, by means of which the functions of the liver may still be discharged. "Under extraordinary circumstances almost every organ of the body can do more than the amount of its normal activity; it possesses, as one may say, a reserve power, exceeding its usual work, which may still further be used."[1] Similarly we may regard the adaptive power of the muscular and connective tissues for uses beyond their natural wont, in case of injuries or demands upon the body which otherwise might not be met. For instance, Roux has shown the wonderful manner in which the fibrous connective tissue in the caudal fin of the dolphin is adapted to a rudder plate, as it is moved in many directions by the action of the muscles, and thereby rendered in special parts now stiff, and again flexible.[2] This limited power of substitution of the work or function of one organ for another, shows again the strong restorative energy which is inherent in living matter. Nature, when foiled in the effort to replace an injured member, may stimulate another organ to do extra work.

[1] Hertwig, *Die Zelle*, s. 165.

[2] See, for this and other instances, Hertwig, *Opus cit.* pp. 172–175: Herbert Spencer, *Princ. of Biol.* i. § 60.

Still another kind of natural substitution is to be mentioned; it has been called anticipatory substitution, or the temporary use of some provision until a better form for the same purpose shall be grown. A noteworthy instance of this kind of predictive substitution is found in the history of the formation of the backbone in the Vertebrate embryos. Professor Thomson has thus described it: "In all Vertebrate embryos there is, for some time at least, a supporting axial rod or notochord, developed along the dorsal median line of the primitive gut. This persists throughout life in the lancelet and lamprey and a few old-fashioned types, but from fishes onwards it is gradually replaced in development by the backbone. The notochord does not become the backbone, which has a different (so-called mesodermic) origin, but is replaced by it. The notochord is a temporary structure, around which the vertebral column is constructed, as a tall brick chimney might be built around an internal scaffolding of wood." Mr. Thomson adds: "Of course we require to know more about the way in which the old-fashioned structure prepares the way for and stimulates the growth of its future substitute, but the general idea of one organ leading on to another is suggestive."[1]

In this connection we may observe also a somewhat kindred power which may be characterized as a persistent tendency in evolution to find new methods when old ones seem to have reached the end of their usefulness. Perhaps this characteristic might be called a reformative rather than a restorative power of nature. You can

[1] *Science of Life*, p. 137.

observe it in general by a mere glance at the development of the chief animal types. When one way of development seemed blocked, and there was no progress farther in that direction, evolution found another way, and went forward again on that new road. One original way of life was tried in the mollusks. The animal threw a protective shell over itself, and settled down comfortably in the mud. When irritated by a parasite, its easy and indolent defence was simply to secrete a pearl. But the protective shell becomes eventually a hindrance and prevents life from gaining sense and freedom. The oyster is conservatism in its shell.

Soon nature takes up another model. The vital organs are still protected within a horny covering, but the body is divided into segments, muscles are developed, and organs of sense and locomotion. More attention is paid to brains; and insects like the busy and intelligent bees, represent nature's next method of reforming her vital moulds. But erelong that way of development seems blocked. The model chosen is excellent for swift flight, and some head also is gained in the insects; but an external kind of skeleton has its limitations, and the insects, after starting out in a promising direction, came to a standstill in size and intelligence; — nothing more excellent seems to remain to be achieved in that direction. Nature, not to be foiled, finds a new structural plan. This time in the vertebrates she puts the skeleton inside, and tries again. Huge reptiles are produced, great birds and uncouth monsters destined to receive in time as uncouth Latin names in our zoölogy. But again the way of progress in the development of muscle opens no further possibility. The greatest athletic age was the carboniferous period. There were giants in the land, and in the water, in those days, only they had little intelligence to do team work. Again nature improves her working model. This time she pays special attention to the nervous organization; that takes the chief place in the development, until at last the race ceases to be to the swift and the battle to the strong, and a man's life consists not in his brawn but in his brains. We might form some idea of this general character of evolution, if we should compare it with the improvement which man has made in building vessels, putting side by side the many successive models from the original dug-out of a savage, or a Chinese junk, or a Nova Scotia schooner up to the finest yacht, or the swiftest ocean greyhound. Yet nature's work of improving her models has been a greater — shall we not say — a more thoughtful development.

What, then, we are now ready to ask, is the full and final significance of such facts as these, which show a conserving, regenerative, and in a sense reforming energy and tendency in the nature-process?

The mechanics of bodily regeneration have constituted a distinct problem in biology. How was this power originally gained, and how or why in the higher organisms has it been repressed? This is a twofold question. If we assume that in its origin this power of an organism to reproduce a lost part of itself is something very like its natural power of growing, and that regeneration originally is associated with growth-power, still the question remains, How has it happened that this ability to repair loss has diminished with increasing organization until among the higher animals almost no regenerative power remains? Mechanically this may possibly be explained as a consequence of increased differentiation of structure. The structure may become so specialized, and each specialized organ may represent so long a course of development into which so many different factors have entered, that the primal regenerative power, characteristic of simpler tissues and less complex cells, may have ceased to be sufficient for the task of restoring anew a mutilated or lost organ, such as an eye or a lung. So far, then, biology may go in explanation of the facts of natural regeneration. Interpretative philosophy has next to take them up, and to consider their value as indications of the character of evolution.

We may rationally understand this tendency in the nature-process to repair loss as a disclosure of its first good intent. Natural regeneration is a sign of original good character in evolution. If evolution be morally chargeable with waste, and with leaving open possibilities of evil, it must also be credited with a primal tendency to repair loss. If nature admits evil, it also reacts against evil whenever it becomes actual. Nature has at least so much moral character from the start as this restorative power may signify.

Again the law of the diminution of regenerative power appears to be part of the cost of higher life. It is loss for gain. This likewise is a good sign. Natural selection carries with it the corollary that the utmost possible shall be made of living matter. All that can be gained is to be won from the struggle of existence. Now for the sake of making, or to speak scientifically without reference to ends, in the course of making the utmost possible out of living matter, a decrease of its self-restorative power has become unavoidable; it may prove to be a mechanical necessity, if you please. The failure of this power becomes thus a necessary part of the cost of evolution. It must lose much, that it may gain more. It is the price paid for advancement along the line of organization. In order that a finely specialized organ, like the eye or the brain, may fulfil its function, its total living energy — the sum of the energies of its cells — is concentrated on its specific activity; its whole available vitality becomes engaged in fulfilling its special function; it has no surplus left by which to renew itself, if it suffers loss. Very much as a man absorbed in a work which tasks his highest powers, loses aptitude, and has no strength for lesser work; so finely specialized organs are devoted with all their vital strength to the task which they are called to render to the body. The lower animal power of self-restoration is sacrificed to the higher function. Nature never seems to hesitate to make sacrifices for good results. Nature does not stop to count the cost when an advance in any vital value is to be gained.

Such, then, being the restorative system of nature below man, we must next inquire whether any analogous principle of restoration is apparent on the higher plane of personal life. From the unity of nature we should expect to find evidences of the working of some restorative energy in human life and society. We might suppose that evolution would not lose utterly this primal benignancy, which its regenerative tendencies manifest, when man appears on the dizzy heights of freedom, to experience his awful fall, and to live in the misery and shame of his civilizations. We should naturally look for some new manifestation of this original character of evolution, and possibly for some larger scope and power of it in the sphere of the moral and the social life of humanity.

In one respect, as already observed, the power of regeneration has drawn near its end in man's life. There is not much more of it left physiologically. A little healing power of nature is left in us; and it is possible also that man may possess physiologically some power of acquiring immunity against certain forms of disease. A recent evolutionist indeed has gone so far as to suggest that a natural immunity of mankind from alcoholism might be acquired. If we do not by severe artificial legal selection eliminate the drunkard, natural selection, he thinks, in the course of time might produce a human species immune from the effects of alcoholic drinks; only it is added that in this way of temperance reform the world "will never be thoroughly sober until it has first been thoroughly drunk."[1] Probably hereafter more restorative power for our life may be called forth and directed by sanitary efficiency and medical knowledge to the relief of much sickness, suffering, and waste.

With this primal principle of natural restoration to guide us we approach the problem of evil in our human

[1] C. A. Reid, *The Present Evolution of Man*, p. 370.

life, and behold prophetic light thrown upon it from the past. Nature has not written over any gate of life, "Abandon hope all ye that enter here." Even when one way has ended in a blank wall, erelong another gate has been found and flung open, and life has passed on rejoicing and hoping again. Neither nature nor Christianity is a pessimist. There was one pessimist, indeed, among the twelve disciples; but he was that man who went out in the dark, and hanged himself. He knew not that the wasted ointment, as the story of it should be told wherever the gospel is preached, would be worth more even in relieving the wants of the poor, than it could have been had every wasted perfume of it been turned into bar of solid gold. We have found how natural wastefulness beneath us may be eventually a benefit and service for life. In moral continuation of the great principle of regenerative vital power there may be redemption for man even at the cost of sacrifice. On the higher plane of personality power to restore a limb or an eye has been lost; but power to renew a mind or to redeem a soul may be waiting its appointed hour of manifestation. Nature's earlier virtue of regenerative energy may be carried in the highest sphere to full completion in some redeeming grace. Again it is a question of fact and of history. Has the Spiritual Power in which the universe is constituted, revealed itself in human life and history as a redeeming potency and promise? There would be no unnaturalness in its working, if in our moral life we should find evidence of its operation. If from observation of human affairs, or from the special course of man's history from Moses to the Christ, or in the day of his grace ever since, we find good reason to believe that there has been and is a renewing energy of the Spirit, working in vital union with man's life, and that humanity is capable of such spiritual regeneration; there would be in such belief nothing unnatural, nothing contrary to the natural capacity of life for regeneration from the same source and power from which it came forth. Capacity for regeneration, in each order of life after its kind, is one of the essential vital capacities. The Christian redemption is not to be regarded as something apart, as an isolated and artificial provision of divine grace for man; it falls rather into the universal order, and it will bring to highest and farthest ethical and spiritual completion one of the first principles in which nature itself is organized. For among other laws nature is made on a restorative principle. There is, as the Christian word assures us, an eternal purpose of redemption.

It must suffice for our object only to glance now at the operation of the natural principle of restoration as it is manifested on the plane of personal life. Further discussion of it belongs not to natural theology, within which our present discussion is confined, but to the philosophy of history, and especially to the Christian doctrine of grace.

We may mention, however, two aspects of the vital principle of restoration in its higher and freer working on the moral plane, which may receive some illustrative light from the lower world.

We refer for one to a working principle of nature which may be called the law of release of spiritual energy, as the evolution advances. Not only is it true that better adaptations for intelligent use are gained, but also it is true that with improved forms intelligence, immanent in nature, is set free for greater exercise of its energy.

A spiritual energy which is held subject to other powers in a lower order of life, may be released from the conditions which had limited it, and spring unbound to freer play, and serve larger uses in higher orders of being. This holds true, for example, with regard to the use of intelligence in the higher animal world. It had little scope in the limited nervous responses of the lowlier organisms. Mind was held in bondage among the simpler animals. Intelligence is somewhat released, it is given larger range, it is freed for better service, among the higher animals. The radiates, for instance, have such heads, or nervous centres, as they possess, located near the middle of their organization; the lower types of animals have met with but partial success in the attempt to twist themselves into such shape that, with their eyes more to the front, they might creep or swim with less devious motions. Such glimmer of intelligence as may be granted them is limited in its use by the position of the nervous ganglia at the centre, or on one side, of their structure, with their eye-spots on the edge of their mouth, or at the ends of their rays or arms. They can crawl around, but they cannot move far with straightforward intention. But some mollusks, like the squid, being built upon a somewhat improved plan, have managed to get their heads to the front, and as they have developed more motor organs and a better nervous system and prominent eyes in their heads, animal intelligence finds freer play in them, than, for instance, in the star-fish. The squid can use its head to some purpose as it moves about. It is a gain for the exercise of intelligence when an organism can see and move straightforwards. In other words, there is a release of intelligence from material limitations when the head and eyes are brought into the line of motion; the vertebrates dart through the water, or fly through the air on wings swift as thought. Every improved specialization of structure sets animal intelligence free from some limitation, and renders it capable of more co-ordinated and seemingly purposeful activities. Not to multiply illustrations, it may be stated as a general law that with the development of life there is a larger release of the energies of intelligence from natural bonds under which they were held subject in lower organisms, existing under more limited material conditions.[1] The human will in its free action is the final, splendid witness to this natural law of the release of spiritual force. What can it not do! The only ultimate limit to will is another will. The material world offers means for the activity of the spirit, but no final barriers to its power. A person can be withstood absolutely only by a person. Will is bounded, not by matter, but by will — man's will by the will of God.

[1] Compare this remark of Mr. Morgan: "Mind to some extent escapes from its organic thraldom, and is free to develop, still in accordance with the natural laws of its own proper being, but in relation to a new environment." *Habit and Instinct*, p. 334.

Now this same law holds good likewise of this principle of restoration. Its spiritual power is released, its sphere of operation is enlarged, its triumph becomes more glorious in the highest dispensation of life. Lower down, as has just been said, a lost limb may sometimes be restored by nature; a mutilated form may be reconstructed; to a limited extent the function of one organ may be substituted for that of another, or an anticipatory service may be rendered by one part for the sake of the growth of a better form; but no more than this can be wrought by the restorative power of nature under the conditions of her plant and animal life. And in the physiological order, regenerative energy soon reaches its necessary limits. But restorative virtue is set free for grander service on life's highest plane. In the evolution of man the regenerative principle becomes a dominant factor. In the human world it has large, sunny scope; in the moral sphere it becomes a quickening Spirit; and in the history of man's fall and redemption, free grace, which was never contrary to nature in her earlier and physical regenerations, becomes the distinguishing and crowning glory of the highest dispensation of life. So love, which was rudimentary and held in bondage, as it were, in the lower nature, is made free, and in the life of man love becomes the greatest of all. It is for Christian theology to show further how redeeming love works according to the natural laws of regeneration. God acts always naturally, in every order of being according to its kind, and in all the spheres everywhere like Himself.

The Christian theology of redemption might be clarified and enriched by a careful comparative science of the principle of restoration in all orders and spheres. Its workings, its methods, its limitations, its increase of opportunity, should be compared in the history of the world before man, and in human society. True analogies from the lower to the higher realms — analogies which are real and not misleading, because grounded in the unity of the Spirit in all the worlds — would thus be rendered available in Christian teaching and preaching. It would be profitable, for example, to institute a comparative study of the method of salvation in both the lower and the higher orders of nature in such particulars as these: — first, in the direct working of the forces of vital repair and renewal; and, secondly, in the special method of substitution. For substitution, as we have just observed — substitution which even on nature's lower plane involves rudimentary sacrifice — is one of the great natural principles of regenerative life. Vicariousness, as such comparative study may teach our theology afresh, is a principle laid in the very foundations of the world. Vicariousness is not contrary to nature's heart. There is an eternal atonement. We have much still to learn concerning the deeper naturalness of the love of God in Christ. But we glance in this direction only for a moment, that we may indicate a way of further rejuvenescence of Christian theology, which the new natural theology opens for faith.

One other striking aspect of the principle of restoration, as we see it developing alike in nature and through human history, should not be passed by without comment, for it offers a further and impressive sign of the moral character of evolution as a whole. It is a feature of it which may be designated as the law of diminishing sacrifice and of increasing service.

It is a signal fact that as evolution proceeds and the higher spiritual forces of life are released, the necessity for sacrifice diminishes, while at the same time the field for service is enlarged. We have already observed the rudimentary forms of mutual service which are to be seen in primitive colonies of cells, in a division of labor between associated cells, and later in vital co-operation between the fully developed organs; still further we may note those curious instances in which different animals help each other live, which are known in the books as examples of *Symbiosis*, or living together. An early instance of this method of mutually dependent life — to mention one for all — is the interesting case of an ordinary *Radiolarian*, the life of which is maintained by a partnership which was at first a complete puzzle to the biologists. It is now known that certain little yellow cells, which are found embedded in a *Radiolarian*, are distinct animals, which live upon the carbon and nitrogenous waste of their host, and which in turn repay its hospitality by decomposing its carbon dioxide, and giving it back free oxygen for its breath of life, and also through their own bodies supplying it with two important elements for its protoplasm. Service, mutual service, which in *Symbiosis* is seen to obtain as a law at the very root of life, becomes a more marked and prevalent principle all the way up. But on the other hand is not sacrifice, involving a seemingly immense waste of life, one of nature's obvious first principles? Life preys upon other life. Life is sacrificed to life. Service for a long while seems to be but little, and sacrifice everywhere and everything in nature. Nature is "red in tooth and claw." But look again and again. Make cross-sections through living nature at different periods, after long intervals, and what do we see? What but a diminishing use of sacrifice, and an increasing use of service. This holds true in the higher plant and animal world. Amid destructive competition helpful co-operation begins to count more.[1] We find, not every creature warring against every other creature, but flocks and herds, and various animal associations for mutual protection and help. As nature's ideas become evolved, it is found to cost less waste of life to preserve life. The race though still to the swift, and the battle to the strong, becomes less deadly. The reproduction of the species grows less sacrificial. Parents survive as trainers and helpers. Motherhood costs less sacrifice, and means more service. Travail and pain are forgotten for joy that a man-child is born into the world. Human motherhood shows that a serene height has been reached where one life does not need to be given up wholly for another life, but where the mother's life may be happily and helpfully prolonged for the other life of the child. In the human home sacrifice has become the vanishing element, and mutual service the dominant joy. Or, sacrifice, if it still must needs be, is

[1] This law comprehends the truth of the apparently altruistic side of evolution, which Mr. Drummond has poetically depicted in his *Ascent of Man.*

there transmuted into service and glorified. More and more in the history of the world, as the higher energies of spirit are set free and prevail, nature's first hard necessity of sacrifice grows less, and service in its joy prevails. Cross-sections of human history, if made at different levels or ages, and compared with one another, would demonstrate this gracious character of the higher social evolution. Even war itself, as it is rendered more costly to a nation's treasury, and more deadly in its implements, becomes less fatal in its battles; wars cost less life as civilization grows. The casualties were vastly greater in the ancient wars of the Assyrians, the Medes, and the Persians, than in modern battles. They were larger in mediæval combats than in later campaigns. They were greater proportionally even in our civil war than in more recent battles. In our time, moreover, the great world calls for only occasional heroic sacrifice, but it offers a wide field for daily service. Nature's first law is one of sacrifice; her last law of life is one of service. The sacrifice of the Son of man, the supreme sacrifice of history, was atonement offered once for all: an apostle could find it needful only to fill up that which is lacking of the afflictions of Christ. And that is a diminishing need as the Spirit of Christ prevails. The summons for the martyrs ceases; the opportunity for a life poured out in some single and splendid act of sacrifice becomes rare; but faithful lives of mutual service find their happy day in all Christian communities. Sacrifice, in short, may pass away; but love abides forever.

Still we must ask, Shall there remain for life in the highest no more pain or death? Shall sacrifice pass entirely away, and the heavenly service only remain? Shall death itself at last be dispensed with as no longer needful for life and its perfect evolution? Before we are quite ready to give to this supreme question of our human destiny the fullest answer which may be derived from the study of evolution, we must turn once more to the facts, and inquire concerning another great constructive principle of nature. Then we may seek to combine all these lines of inquiry together in our rational and spiritual interpretation of the universe, amid the lights and shadows of which we now walk, and wonder, and believe and wait.

CHAPTER XI

THE PRINCIPLE OF COMPLETION

An eminent German botanist, Nägeli, in the introduction to a book in which he summed up his investigations into the life of the plants, wrote of a principle of perfection which he had discovered in his studies of nature. Something running through the development of the plants and the flowers had impressed him with its all-pervasive and dominant presence; and he characterized it by this significant phrase, a principle of perfection.[1] After the habit of strict scientists he was careful to disclaim any metaphysical intentions in the use of a phrase so idealistic as that; he explained that he meant to characterize by means of it that progressive tendency which seems to be of the essence and movement of the whole living process of nature. Without adopting or discussing Nägeli's biological views, we may take his phrase as a happy designation of an impression which the all-around naturalist often receives from his studies. Nägeli is not the only biologist who has dropped into the use of such significant expressions. The phrases, a tendency towards perfection, a progressive tendency, progressive development, and other words implying movement towards some end to be realized, frequently

[1] *Mechanisch-physiologische Theorie der Abstammungslehre*, s. 12.

creep almost unawares into strictly scientific essays, even where the best intentions exist of keeping out any confusing metaphysical ideas.[1]

The impression of some formative and perfecting principle in nature is a suggestion which naturalists, who would see facts in their larger outlying relations, will not wish lightly to brush aside. It is nature's response to their own thought. It is one of those impressions which are received by the mind that looks into nature from the mind which is revealed through nature. Do you say, No, it may be only our mind seeing its own image in nature's glass? But how do you know that? How do you know that nature is a mirror, and not a revelation? Evolution is thoroughly real, and leads us to believe in the realities of things. We have no knowledge to warrant us in saying that at the back of nature's glass is only so much foil, and that nature is but a deceptive mirror of our human face; it is as scientific, it is truer rather to say, Any light we may see in nature is light shining through it. Nature is not a mirror of our consciousness, but a glass through which

[1] For instance, one of our American biologists, in describing certain processes of regeneration, remarked that "what we call correlation of the parts seems here to belong rather to the category of phenomena that we call intelligent than to physical or chemical processes as known in the physical sciences. The action seems, however, to be intelligent only so far as concerns the internal relations of the parts, etc." But the next year he offers an apology for his having fallen into a metaphysical pitfall, and says that "it is true that at present we cannot explain them (these reactions) as the result of known chemical or physical properties of matter, but I do not think that therefore I was justified in calling them intelligent processes, even in the broadest use of the word, etc.," Morgan, T. H., *Wood's Holl, Biol. Lectures*, 1899, p. 204; and so he leaves his previous words without much intelligible meaning.

we look out, and the eternal reality shines in. The background of the universe is not metallic foil, but spiritual reality.

The modern botanist, Nägeli, was not the first to discover a certain principle of perfection in nature. Long ago that great naturalist, as well as philosopher, Aristotle, spoke of a perfecting principle in nature, recording in the phrase the impression which nature itself had made upon his keen observant mind. It is in some sense a return to Aristotle, when modern biology puts at the focus of our philosophy of life the question, How has nature taken form? Plastic material, not inert substance, has been worked up, and received shape and order and comeliness in evolution: what have been the formative forces or processes through which it has taken shape and been so far perfected?

In pursuing further this discussion, it is preferable to substitute for Nägeli's phrase, the principle of perfection, this expression, the principle of completion; partly because the latter phrase avoids at the outset any moral implications, and also because it will be found to describe quite accurately the facts and tendencies which come under observation.

At this point we must return to our previous reasonings concerning the fact and character of direction in the nature-process; but these will appear to us in this further consideration of them under a new aspect. Taken in connection with what has also been observed concerning the process of individualization, the whole matter will begin now to open towards the prospect of some completion for our all too broken human life.

It is not necessary to repeat, but we should now keep in mind, the successive facts and interpretations which have already occupied our attention; for they constitute the broad basis for further argument. We shall seek to bring out their bearing in particular upon the possible completion of life.

The evidence of a persistent tendency towards completion in nature lies broadly and largely before us in the fact of the progressive adaptation of life. So eminent a biological authority as Oscar Hertwig holds it to be scientifically true to apply this expression, the principle of progression, to the development of nature as a whole. "The most remarkable example," he says, "of a progressive process of development is to be found in every ontogeny (the individual development) from the egg. For every stage of it is the preparation for the following, and the process goes on towards its realization unceasingly, so far as the outward conditions also . . . exist. Even slight disturbances from without cannot stay the process in its progression, as there are various means of overcoming and equalizing them, so that the course of development is constantly brought back to the goal fore-designated by its nature, and it presses towards its ordered goal." So Hertwig would regard, likewise, the natural historical method of evolution in general as in a similar manner a constant and orderly progression, not as a play of accidents, but as possessing the same inner necessity as the ontogenesis of the egg.[1] Simi-

[1] *Die Zelle und die Gewebe*, p. 278. Similarly, another eminent German investigator, Driesch, has been led by his studies of ontogenetic and reparative processes to modify his earlier "machine theory" of vital

larly an American authority, Professor Wilson, in speaking of different forms of cleavage which are to be observed in the development of the egg, says: "We cannot comprehend the forms of cleavage without reference to the end-result."[1] That remark holds true all through nature. We cannot comprehend what is to be seen at any cross-section of natural processes without reference to the end-result. At no period does life appear like a little boat adrift aimlessly on the vast ocean of existence. It is never a derelict. However buffeted and tossed about, it is always moving and struggling on towards an "end-result."

This teleological character of the nature process as a whole — its habitual way, that is, of working towards ends — impresses itself upon a thoughtful observation in many ways. We realize it when we reflect how often the same material has been worked over by nature, and worked up into better forms. For the same atomic matter on this earth has been worked over and over with ceaseless thrift, and the utmost has been made of it, in the history of plant and animal life. Adaptation after adaptation is introduced, form after form is selected, naturally happy hits, if you please, are seized upon and used for still further advantage, all in the

action. He now recognizes a special law of vital procedure ("eigenthümliche Geschehensgesetzlichkeit"), which is not subordinated to, but co-ordinated with, the causal forms of connection in the inorganic world. *Arch. f. Entw-Mech.*, Bd. viii. s. 35. O. Hertwig in a recent address, *Die Entwicklung der Biologie im 19. Jahrhundert*, reasserts with even more distinctness the views to which we have referred. *Per contra*, see O. Bütschli, *Mechanismus und Vitalismus* (1901). The notes contain references to recent utterances on this question by German authorities.

[1] *The Cell*, p. 377.

ceaseless effort apparently to make the most and the best of the matter of life. The same particles may have been used in the meshes of a vegetable mould, in the single vaguely sensitive cell of a protozoan, in the more organized body of a mollusk, in the warm blood of a bird of the air, in the brain of a statesman, in the heart of a saint. Nature will do her utmost with the material given to her hand. And nature's utmost is nature's best. Never weary in doing good, fainting not along life's long way, pressing on towards the goal, nature strives to apprehend that for which also she is apprehended. Nature, give her time, will fulfil her whole law of perfection.

This same impressive conduct of nature, as of an intelligent working toward completion, appears not only in the large, but also in particular instances of her progressive adaptations, as when we survey the rounding out of individual life-histories into completed circles; — if we consider, for example, her procedure in the course of the lives of certain animals which pass through successive and seemingly disconnected stages, but which complete a perfect circle in their development. We may select as an example Mr. Morgan's account of the interesting and singular career of the *Yucca* moth. This silvery insect emerges from its chrysalis-case "just when the large yellowish-white bell-shaped flowers of the *Yucca* open, each for a single night." The female moth gathers the golden pollen from the anthers of one of these flowers, and kneads it into a little pellet. Laden with it and holding it, shall we say, carefully, she flies off and seeks another flower.

Finding it, "she pierces with the sharp lancets of her ovipositor the tissue of the pistil, lays her eggs among the ovules, and then, darting to the top of the stigma, stuffs the fertilizing pellet of pollen into its funnel-shaped opening." The visits of the moth are necessary to the flower; else it would remain unfertilized. And the fertilization of the ovules of the flower is necessary also to the larvæ of the moth; for they feed exclusively on the developing ovules. "Each grub consumes some twenty ovules, and there may be three or four such grubs," while the ovary may contain "some two hundred ovules."[1] So they both get along together very well. The plant makes a partial sacrifice of its seed to the moth, and the moth brings the means of fertilization to the *Yucca* flower. The moth performs all this wonderful adaptation but once in her life; her offspring she never sees and cannot know. She has no means of understanding the effect of what she does either upon the plant or for her eggs. Yet to this good purpose she toils, and to this end nature blesses her work. Here certainly is a wonderful sequence of activities and adaptations, and through this whole series nature works for definite end-results. By this combination of elements of plant life and activities of animal life, nature secures the benefit of both. There is to be seen here a co-ordination of many factors for results; and these results are themselves also part of the general movement and process of life's perfecting. In this instance — and many similar ones can be given — one might miss entirely the connection, and fail to trace the self-completing life-history,

[1] See Lloyd Morgan, *Habit and Instinct*, p. 14.

had not the whole series of nature been observed. It is an instance to show how nature fulfils herself in many ways. With a whole completed life-history before us we can perceive a truth of large suggestive import, — how things which seem strange and unaccountable when seen separately and regarded only in relation to a limited period of the life-history, are explicable and fall into a good whole, when seen in their relations to other parts and as moments of one well-ordered process. Each act and instinct of the *Yucca* moth, as well as each arrangement of the *Yucca* flower likewise, is sign of that all-pervasive tendency towards completion, in virtue of which we may be assured nature everywhere will finish what it has begun. You do not understand what mother-nature may be doing at any moment? Watch her long enough, and you shall know.

This general fact of progressive development discloses, when we look at it more carefully, two distinct features; it is a progressive development both of form and function. Life takes on better form, and it thereby fulfils its functions better. Or, in a word, life shapes itself better for better work. These two, form and function, go together in nature, and each seems to help on the growth of the other.

The swimming bladder, for instance, of a fish develops into a lung; and the lung, when it is formed, discharges better the function of breathing the air. It is an old biological question which is first, — whether an organ is first formed for use, or whether the use develops the organ. Sometimes forms seem to arise in anticipation of some future use. But certainly through the improvement of structure, and the demand upon an organism for better adaptation, life goes on towards perfection. A remark of Mr. Ward's aptly hits this characteristic of evolution: "It has sought not only to live, but to live well."

The fact of this mutually dependent development of progressive form and better adaptation for organic functions, appears even from a cursory view of evolution. Indeed something of this twofold method of progress may have characterized inorganic nature. Astronomical physics has marked successive steps in the formation of the stars. And in the later evolution of the skies two distinct but related modes of formation have been distinguished. One is the development of a ring of more or less nebulous matter; the other is a division of stellar matter into comparatively equal bodies.[1] But as stellar form has thus been gained, the stars have become more fit for use. The hottest, less developed stars cannot shelter any life such as exists on the earth. The more developed worlds may become fit for the abode of life. We know one world at least which has been so formed and developed that upon its surface, and for a few thousand feet above its valleys, it can shelter and nourish something of vital worth, and draw to itself influences from all the stars in its ministering to life. The forms of the stellar universe have become fitted at this earth-point at least to discharge this function of sustaining animated existence. We do not know for what functions for other intelligencies the heavens may have been developed at other shining points: we do know how ages

[1] See *Popular Science Monthly*, Dec., 1897, vol. 52, pp. 175–176.

of inorganic evolution have fitted this earth to be as the garden of life. Now observe particularly that this stellar formation, and this evolution of a world fitted for vital uses, has been progressive and adaptive. It has not been a succession of dissolving forms; it has been one movement on through a series of connected forms. The great heavens have not been as a theatre for the display of changing pictures, but for the evolution of a drama. The history of the inorganic kingdom has not been like a succession of waves, now rising, now falling, always restless, never advancing; it is rather like an increasing number of steps, when each point gained becomes the point of departure for another step in the same direction. However mechanically wrought and mathematically intelligible this astronomic evolution may prove to be, in its fundamental and constant character it has one meaning and worth, — it is a formation for use; it is a movement which ends in service for life. As such it is an evolution which gains as its issue something of higher value than itself. In its use for life it reaches an end, and an end which is worth all the astronomic ages of star-formation.

This same impressive character, which the heavens declare to the modern astronomer, of progressive movement and adaptation for further use — of form fitted for service — may likewise be traced in the geological history of the world which has been made for us. A geologist, Professor Shaler, may best interpret for us this aspect of the history of the earth: "We should also see that the greatest work of the earth, from ancient ages, has been to afford the place on which, as on a theatre, this life has played its part. We find the most wonderful proof of the earth's perfection in the fact that for a time, so long that our imaginations are too weak to consider it, it has been so well ordered that no convulsions have prevented the animals and plants from steadily going forward in their development. Ten miles beneath the surface, there is a heat so great that no life could bear it; ten miles above, a cold so intense that, if it should come to the earth, nearly all created things would immediately die. Yet for ages the balance has been so preserved, and the temperature of the earth has remained so near what it is at present, that these sensitive living creatures have not been killed, but have prospered from age to age."[1]

The persistent working of evolution towards completion appears further when we take a general bird's eye view, as it were, of the course of development by means of which organic form has been fitted for the largest reception and use of intelligence. On the surface of it, from a general glance over the course of it, it appears that from the outset nature's problem has been how to reach a form of life best fitted for the habitation and service of mind. Her great structural lines point in that direction. Her repeated and renewed attempts all lie in that direction. The successive types of the animal kingdom show increasing adaptation to brains and their function. A mollusk is formed but soon left behind, for there is no progress further towards brains to be made by protecting an organism with a ponderous shell. A worm is tried again, and muscles are laid on

[1] *First Book in Geology*, p. 147.

transversely and longitudinally. Some gain in the way towards brains is made next among the annelids and articulates, when more power of locomotion and some beginning of sense-organs are won; when life rises a grade higher than the worm in articulates which acquire a head and legs. In the insects that way is carried as far as their size permits. Nature takes up next the nervous system, develops backbone, and gains larger space in the animal for brains.[1] Intelligence becomes eventually the leading line of evolution. And it is a question which the zoölogists have fairly opened up, but which they have not as yet thoroughly investigated, how far animal intelligence, after a certain amount of it was gained, entered itself as a direct factor into evolution, by its presence and influence shaping its course and uplifting it to higher aim. Mind once gained in evolution becomes henceforth a factor of evolution. It may even seize upon and direct natural selection, exercising as it were from within nature an artificial selection as it brings itself more and more to dominance. But passing this, the immediate point is that through successive types, and on progressive lines, nature has worked out and solved the problem of building a structure which is in the highest degree fitted for intelligence. "The naturalist," as one of them remarks, "cannot believe that man was a mere accident; he is rather the being to which the world in all its efforts was constantly

[1] According to Professor Brooks fossils show that among terrestrial animals, since the Middle Tertiary, the size of their brains has increased over one hundred per cent; the brain of the modern mammal is more than twice as large, compared with its body, as the brain of its ancestors in that geological period. See *Foundations of Zoology*, p. 217.

tending."[1] This fact that there has been a tendency towards completion in nature appears with irresistible force when we follow up through the long ages what has been called the "organic approach to man." It is a long chain of organic events, generations linked to generations, yet it has not been broken, and not a link needed for its completion has been missing. Zoölogists have not indeed found every missing link, but they have laid hands on links enough to be sure of the chain. One hardly knows how to put into words the impression of some determinate connection and of some ceaseless movement towards an end-result, which is made by the attempt to reproduce with scientific imagination this swift yet ceaseless procession of organic forms, this innumerable succession of generations, this steady march and approach, which will not be diverted, of the powers of life on and on, and up and still higher, until the kingdom is come, and Man reigns, and life has become love and worship. It is sober truth and science which Browning utters in *Paracelsus*, —

> "All tended to mankind,
> And, man produced, all has its end thus far:
> But in completed man begins anew
> A tendency to God. Prognostics told
> Man's near approach; so in man's self arise
> August anticipations, symbols, types,
> Of a dim splendor ever on before
> In that eternal circle run by life."

Our argument may be interrupted here by the question whether there are not some evolutionary theories

[1] Shaler, *ibid.*, p. 188. Prof. J. M. Tyler has fully developed this argument in his book on *The Whence and the Whither of Man.*

which may account for this apparent progress towards an intelligent end and final coronation of mind, without recourse to an idea of a goal, or anything resembling a thoughtful moral purpose in nature? Certainly there are scientific theories which are competent to explain, with much probability, although still partially, the methods of this whole progressive course of nature. Let us turn, then, once more to the theories, and see how far they can be made to go.[1] They may account for the manner in which the road has been made; but not for the movement of nature up the way of life. They present for our understanding good summaries of nature's tactics; they do not comprehend the grand strategy of the creation in the order of the heavens and the victories of life. True science, in its present more reverent mood, will have little patience with the flippant ease with which phrases like the survival of the fittest are popularly used, as though by words the worlds were made.

The chief means of progressive evolution may still be described in general by Darwin's formula of natural selection. It is by no means certain, however, that Darwin's formula for the creation is comprehensive. Nature may have other arrows in her quiver, and more than one way of hitting her mark. We know as matter of fact that one way of her success in promoting life is to eliminate the unfit. Nature is repeatedly subjecting life to severe examinations, and the creatures who miserably fail of the test are left to perish. To some extent this method of evolution through natural selec-

[1] See p. 80.

tion may be said to have been experimentally verified. For example, on February 1, 1898, nature held an examination of blackbirds in the city of Providence, Rhode Island. The test was a severe snowstorm. One hundred and thirty-six birds, that had apparently succumbed to the icy blast, were brought into the laboratory of Brown University, and the attempt was made to revive them. Sixty-four of these birds perished; seventy-two revived. It was found by careful measurements that there was a reason in the structure of the birds for this survival difference. Natural selection, we are told, was most destructive of those birds which had departed most from the ideal type; those survived that came nearest the normal type. The best fitted birds passed the examination of the snowstorm; those not so well prepared failed and perished. By such repeated examinations, moreover, the standard of excellence is kept up. Natural selection acts thus as a perfecting principle of life.[1]

When all this has been granted, many questions remain. Are there other formative forces? And particularly what are the causes of useful variations? The rôle of variation, as it shall be restudied and be better understood, may disclose to us much more than we have known of the ultimate character of natural evolution. We must leave the biologists to work out further this complex problem of the formative methods of life. Some investigators find hints and suggestions of what they call Anti-Darwinian factors in evolution. It is generally agreed that the problem is a vastly complex one.

[1] *Wood's Holl, Biol. Lectures,* 1898, p. 217.

One of the chief questions which biologists since Darwin have been trying to solve, relates, as just suggested, to the causes of variation. Do variations occur in all possible directions, while natural selection prunes off the poorer ones and lets only the fittest grow? Or do some variations regularly recur in definite directions with accumulating results? If the latter be the case, and an organism may evince an inherent tendency to pursue some definite and advantageous line of growth, then some other force besides the action of natural selection must be found as a true cause of evolution. The question also is now raised whether natural selection has worked, as Darwin assumed, through numerous slight, scarcely perceptible variations, during a long period of time, or whether sudden, single variations have been seized upon and held fast as the means of forming new species.[1] Professor Conn seems to state correctly the drift of opinion among American naturalists especially, when he says, "Now it has been a growing conviction of the last ten years that variations are not simply haphazard, but are determinate. This has

[1] Mr. Bateson's work on *Materials for the Study of Variation* has opened a fresh field for research in this direction; he finds evidence for discontinuous variation. One of the latest modifications of Darwin's theory is proposed by the botanist, Hugo de Vries, in his recently published volumes on *Die Mutationstheorie.* In his view sudden, single variations, rather than slight individual variations, produce new species, and in some instances in a few generations. Evolution in this conception of it would not resemble an ascending plane, but rather a flight of stairs, — a new species represents not so much an accumulation of imperceptible differences, but a new step of nature. These mutations are still under the law of natural selection. But this whole field is open for investigation, and in botany rather than in zoölogy the causes of variation now at work may best be studied.

been recognized by many naturalists working in different lines. It has been variously called 'conscious force,' 'self-development,' 'directive tendency,' 'determinate variation,' but in all cases it is the recognition of some force at work *prior* to selection, which controls variation in some way."[1] The palæontologists seem to be especially impressed with the fact, which their study of the geological succession of animals emphasizes, that the "development of types progresses steadily onward in a given line." They find "ever a constant progress apparently toward a definite goal. After a group of animals starts on a certain line of development, it follows it with unmistakable directness. What is more significant is the fact that many kindred groups follow the same line."[2] This is a present biological task to settle the question by new studies of nature, whether natural selection is sufficient to explain the method of this progressive development along definite lines with a seemingly irresistible tendency, or whether we still need to learn much more of the way in which nature has managed to press on as toward a goal. It may be that the answer to this problem will be found to transcend pure biology, and that the final explanation of progressive evolution must come from the spiritual side of the universe. If we would fill such phrases as internal growth-force, or a perfecting or progressive principle, with real meaning; if we may gain more than a merely verbal explanation of the fact of progressive evolution

[1] *Method of Evolution*, p. 364.

[2] *Opus cit.*, p. 365. Among palæontologists Prof. E. D. Cope has argued vigorously that evolution follows definite lines of direction. See his *Primary Factors of Organic Evolution*, and *Origin of the Fittest*.

towards definite ends, we must sooner or later put spiritual meanings into biological phrases. Whatever the way or means of it, the fact of determinate variation, for its ultimate account of itself, suggests intelligent co-ordination and direction. The more our biology can find out concerning the mechanism of it all, the better; for when the mechanics of the universe shall be known no more in part, but fully, we shall be in the best possible position to understand the necessary place and function of divine Intelligence in it. If we can ever run our scientific tunnel far enough *through* things, we shall probably come out into the same light of life from which we start. Think a little, and you may find yourself in the dark and the damp. Think long enough and deeply enough, and you may think yourself through, out into the divine sunshine.

In this connection we would note the fact that Mr. Wallace, who with Mr. Darwin discovered the rôle of natural selection, and who is disposed to assign to it the leading part in the drama of life, nevertheless has marked some features in man's development, physical as well as mental, which he says he cannot account for solely on the principle of natural selection. He suggests that in man's development a higher Intelligence may have guided its course, very much as we may artificially direct natural selection in raising new varieties of plants or animals. Whereupon a French critic of Mr. Wallace upbraids him for regarding man as God's domestic animal. The critic, however, may have touched by that phrase a more vital truth than he knew. For it is conceivable that by a higher Intelligence natural selection may be guided to special ends. In that case a special providence would not be a violation of natural law, any more than the artificial selection of the florist or the pigeon-breeder is a violation of natural law. It would only be a specific use of it by an Intelligence possessed of knowledge enough so to use it for his own good purpose. But more than this may be suggested to us by the phrase, which we need not altogether dislike, that man is God's domestic animal. It may still further and more profoundly be true that life in its higher forms, through natural selection if you please, acquires more and more power to be domesticated. It may gain wider range of variability and increased capacity to be guided and trained to some specific ends, if there be Intelligence so to befriend and improve it. The acquisition of mental and moral power to be domesticated by the God of all, may be itself one of the spiritual achievements of evolution. On the basis of the general providential direction of the whole nature-process there may be formed special aptitudes for definite workings of the Divine energy. If so, such special guidance of man's thoughts, or inspirations of his heart, would not be an intrusion into the natural course of life of something foreign to it, but rather an answer to its true prayer and a fulfilment of its naturally acquired capacity to be moved and guided and uplifted by the Spirit. Religion would be the supreme naturalism. A special providence would thus be a meeting and matching at the prepared point of the inward capacity and the outward, spiritual Power. If man be in deed and in truth God's domesticated animal, the old parable of the Master does not lose its force; for the Shepherd goes before the sheep, and the sheep know the Shepherd's voice.[1]

At this point we pause to note both the agreement of our reasonings with biological science, and the divergence of our conclusion from some evolutionary philosophy. We have accepted from the start the first article of the scientific creed; viz., the genetic unity of the whole creation. Without hesitation we would regard man as belonging to the universe, and himself included in its development. His life is possessed not of less, but of more value, when we consider what it has cost. All the world has been given to enable him to have a soul; shall he then give his soul in exchange for the whole world? But our interpretation of the nature-process as a whole, and its end-result, differs totally from that evolutionary philosophy which can discover in it only movement without aim, and change without progress. A German physiologist, from whom we may learn much as to the facts of evolution (Verworn), would lightly waive the idea of an advance and hence of a goal in nature. He remarks: "The conception of advance, of perfecting, involves a goal toward which the advance is directed. Without this it is an empty conception."[2] That is truly said. To perceive a fact of progression through a series of forms, and to deny the idea of a goal, is to empty the process of its meaning. That is precisely our position, that our entire

[1] At this place in the naturalist's view room would be opened for the Christian doctrine of prayer and its answer.

[2] *Gen. Phys.* p. 318.

knowledge of the nature-process is rendered vacant of intelligible meaning, if it is emptied of the idea of a goal. Professor Verworn, however, after noticing the necessity of the process of organic development, continues in this strain: "The employment, therefore, of the idea of advance or perfecting is evidence merely of an anthropocentric standpoint: we introduce ourselves into the development as the goal." Yes; but the fact is we do not introduce ourselves; nature has introduced us into the development as a goal. Here we are. And we are here sufficiently evolved to need considerable explanation. We are here to know ourselves, and to interpret nature. If at the end of a long tramp through the wild forest, after following the trail all day long, you come out to a clearing, and find a good camp and supper, and companionship of men, you have a right to infer that the tote-road which you had followed must have had some reference to the logger's camp and fire as its end. Nature herself, as the end-result of her own process, has brought us to an anthropocentric standpoint. But Verworn continues: "The goal is an artificial thing which does not exist in nature; the assumption that mankind is more perfect than an *amœba* is not justified by reality." We may observe that it is justified on our scale of vital values; and that scale corresponds to the reality. Evolution has brought life up to a point of organized life and happiness where we naturally assume that a man is of more value than an *amœba*. That man would be far too modest who should waive this human claim. In fact this philosopher does not so easily escape himself from the anthropocentric standpoint. For he puts an interpretation of his own upon nature's facts, when he empties evolution of the idea of a goal. That is an assertion which he brings *to* nature. Nature certainly suggests another interpretation. Which is the best idea of her processes? We certainly do not know enough to exclude the naturally suggested idea of an end or goal of the progressive evolution of the world. It is sheer presumption to deny it. For the nature-process at least goes on just as it might have gone on, if there is a goal towards which all things move. So, and not otherwise, nature could proceed; in this way of natural selection as an excellent, and possibly as the best way, nature might go on to perfection, if it were from the beginning an ideal creation, and all its elements and laws had been thought out from the beginning to the end. If the Alpha and Omega be Spirit, the process between may be nature. The natural proceeds from the spiritual to the spiritual. It is intelligible only as a process of thought. We only make a needless riddle of natural law, if we say, evolution moves evidently towards an end, and with increasing determination; yet it has no end-result as a goal. Nature going on always without reason, would be forever something inexplicable to reason. We have acquired reason; we turn, and look back, and evolution seems rational.[1] "I know" — so man's self-consciousness finds its supreme expression in the absolute certainty of the Son of man — "whence I came and whither I go."

[1] See Ward, *Agnosticism and Naturalism*, ii. p. 24.

CHAPTER XII

THE PROPHETIC VALUE OF UNFINISHED NATURE

THE French astronomer, Laplace, reduced the heavens to a series of mathematical demonstrations, and had no need of God in his hypothesis. The assertion has often been repeated by those who regard nature as an extended system of mechanics that a Laplacean calculator, if he had a sufficient mathematical knowledge of the universe at any one period of it, might predict truthfully its condition at any future age. From knowledge of a limited arc, it is said, the whole curve of time might be described. All that is lacking is an intelligence omniscient enough to make the calculation. The universe is thus supposed to be comprehensible as a mathematical equation; all that is needed is an intelligence able to work out the equation.

We will not press just now the argument that such mathematical pre-calculation of natural events is conceivable only because the world is rationally made; that the course of nature could be intelligently computed because it is intelligently constituted; and that consequently Laplace may have had more ultimate need of a God in his astronomy than he thought: but we cite this hypothesis for another purpose; it will serve to bring out the truth that in an orderly and intelligible world the known parts and the observable tendencies of things may be enough to warrant some scientific forecast of coming conditions and of further fulfilments. The existing constitution of things has some predictive value. From what is, we may to some extent scientifically forecast what shall be.

This is eminently true of nature's last order of the organic kingdom. Because it is an order, and because it is a developing order, it admits of rational forecast. From the known elements of the curve of our human life, some calculation of its further sweep may be made. The tendency towards completion which we follow within the bounds of experience, to some extent may be followed prophetically beyond the limits of present experience. We may see in what direction it looks. We cannot drop, then, this principle of completion until we shall have considered not only what it means as a character of evolution, but also what it signifies prophetically for us.

What is the outlook for our life from the point of view which our argument has now gained? Regarding evolution as a progressive movement towards higher vital values, and having discovered that nature, in the co-working of all factors, and by every method, makes in time the utmost of her material, and will finish what she has begun, we are scientifically justified in raising the question of most personal concern for us, — Toward what further issues of life beyond life shall the whole age-long process work on? If in seeking answer to this questioning we must look beyond observed facts, we shall sight, as it were, along the line of the known course of nature as we look away toward the world-age to come.

The validity of this principle of prediction from our knowledge of the tendency of nature towards completion, will at once become clearly apparent, if we imagine ourselves to be observers who have taken their stand at some past period of time, in some earlier geologic age, and from that position have sought to predict the future development of the world. We can perceive how an observer so placed, if possessed of sufficient reasoning power, might read forward with much prophetic assurance lines of growth which we have now learned to read backward. The carboniferous age, if observed by such a studious eye, and interpreted in its relation to the preceding ages which had led up to it, might have disclosed signs of preparation for a new heaven and a new earth, wherein the sun should shine through a sky cleared of vapors, and the dry land should teem with fairer life. Or suppose that to an intelligent observer in by-gone geological ages there had been shown some partly perfected organ, like the gills and lung-sacs of larval amphibian animals, or some half-formed auditory apparatus, or an unfinished eye. He would have had for the ground of his prophesying the earlier stages and successive steps up to that time in the history of these organs. He would have noticed their increasing adaptation to a half-disclosed outward element of air and light. He could have followed for some way onwards a seeming progress toward something yet to be revealed. From this history of partial yet definite development he might have predicted better things to come; he might have been reasonably confident that in time a perfect organ of vision would be finished from a primitive eye-cup; or that from rudimentary hearing, like that provided by the bell-like depression and clapper of a primitive ear, or the tuning-fork of an insect's antenna, in the course of the ages an ear for music might be formed. And such prophecy would have become more definite and sure in proportion as the development advanced, — as the lung-sacs became more obviously adapted to some life-giving element, or the ear more responsive to murmurings borne in from the outer air, or the eye more open to a world of color and of beauty. The principle, the sure principle of natural prophecy, is, that partially developed organs, and anticipatory adaptations to some waiting environment are destined to be fulfilled; that nature will not stop nor tarry till all her decrees of perfection shall be completed. Prophecy has scientific claim when it essays to carry out any great vital principle into fulfilments of it beyond our present experience. Such prophecy is first a perception of that which lies vital and germinant in the existing world-order; — it is first insight, and then foresight. The future age is not to be looked for as something which shall come unheralded and with violence from without the existing order of the world. There may be divine surprise in its glory; conditions of life beyond imagination may come as in a moment; but the reality of the hereafter shall be the continuation to perfection of the main lines, and of the essential, vital worths of our present life. Hence our science of life, so far as it may give to us deeper insight into the permanent wants and the constructive principles of the present order, may open for us larger, truer prophetic vision. In this way biology also may be found among the prophets. And our expectation for the future of life on this earth, and beyond that, our hope for the satisfaction of our personal life in some happier environment hereafter, to which all our spiritual powers shall be fully grown, and perfectly responsive, — this grand prophetic trust of our human hearts lies deeply inwrought with this truth that nature can be trusted to keep forever her word of life. She can be trusted to keep her promise of life beyond our sight. The principle of completion will not break down, nor its natural strength be abated, until our human life likewise shall be carried, from the depths of its organic needs, and in the loftiness of its aspirations, to its perfection in the world to come.

Cherishing this clear faith that nature's tendency towards completion will not fail us, as it has not failed the life before us, we may now use it, therefore, with some scientific confidence as a principle of predictive value.

We may confidently make, to begin with, one of the most obvious predictions from this principle; viz., that useful variations will be carried forward to supremacy. It is the known habit of nature to seize upon and make the most of useful varieties. We may expect disadvantageous variations to disappear in time from the life of humanity. The current of human life and history will clear itself, if further moral corruption be prevented. The natural prophets of life are all optimists — ultimate optimists, we mean.

Moreover, we have reason scientifically to expect further and happier adaptations of life and environment, although within limits and through transformations which we shall presently consider. We may count with confidence upon the fulfilment of vital possibilities. The process of making the most of living material has been brought in the history of life so far, and with such persistency, that we may reasonably conclude it will not stop nor be stayed until the utmost that can still be made from the natural material shall have been worked out. These anticipations involve the meeting and harmonizing of inner and outward factors and elements, and the satisfaction in such concord of organic wants. Hunger in nature is always something prophetic. What life begins to need, to feel from within that it must find, shall eventually be supplied from without. And the completed outward conditions will awaken full response from within. The two meet and eventually are matched. The finished eye opens in the perfect light. The process of development through the ages is an evolution of the environment as well as of the life; the end shall be the best possible in the harmony of the two.

On the last height of nature's ascent appears the unfinished life of man. What is its prophetic value?

Man marks the culmination of evolution so far as it has been revealed within the limits of visible nature. The lines of evolution converge all upon him. Its natural prophecies find in him their promised Messiah: — but what does he signify? What does he in his present incompleteness mean? Is his coming the end of the old, or is it also the beginning of a new dispensation? Through his earthly life may we look forward still, or is there nothing beyond, and has all been fulfilled? Is there conceivable a second coming of Man?

In certain directions nature seems to have come to an end, or nearly to an end, in man's physical organization. It is unnecessary to repeat what we have said in another connection (p. 180) of the apparent finality of the adaptations of atomic matter for the use of mind in man's body. A further confirmation of this view that physiological evolution has come to its climax in man, only minor modifications remaining possible, is afforded by the consideration that no great change has taken place in man's physical powers and aptitudes since in some far distant age he first appeared on the earth. Prehistoric man was physically of the same species as the present generation of men. He had, so Mr. Wallace assures us, as large a skull. His physical preparation was sufficiently finished for the beginning of his mental growth. If man's development is to be pressed still further, and a body organized for him of still finer fitness for spiritual service, it would seem that some matter of life, still more ethereal, must be used for higher adaptation to the service of the spirit that is in man. We have no knowledge to warrant us in denying that such finer matter for life may not already exist waiting for man's better embodiment. We can perceive that further ascent, if there is to be such for him, must be won through some natural crisis, and by the appearing at the next critical point of some higher order of existence.

Continuous development for man's life may be reached, as before man continuous development has often been maintained, by an apparently sudden change of conditions, through another and the greatest of nature's transformation scenes. But there are limits in the present visible physical order for man's development; he must live up into a higher order, if he is to pass on.

Suitable illustration of the final limits of one order of nature, and of progress beyond it by birth into conditions which transcend it, may be drawn from familiar fields. The evolution of our instruments of scientific research furnishes a helpful comparison. For example, the telescope has been developed nearly, if not quite, to the limits of clear, colorless definition which are fixed by the laws of light. If our knowledge of the number of the stars is to be carried farther than the eye of the telescope can pierce, we must invent a new instrument adapted to some still higher power of our environment; and this our astronomers have found, for they have availed themselves of the actinic rays which lie in the spectrum above the visible rays, and the sensitive photographic plate, exposed to the skies, has disclosed the existence of stars beyond stars which no telescope can ever reveal. The evolution of scientific instruments for reading the language of the heavens came to an end in one direction, and reached the limit of possibility on one plane, and then it was begun anew on a different plane, and in the revelations of the new the glory of the old dispensation is surpassed. We are thinking that similarly, or in a way in which this may be an aid to our imagination, the spirit in man might be supposed to receive a new instrument for its life, and one of higher power more sensitively adapted to the heavens, than is afforded by a body of molecular matter even in its perfection of adaptation in the human brain to our perception of the visible world. Something more refined than the exquisite nerve of sight, as an organ for man's knowledge, must be prepared for us, to disclose the glory of the heavens which are now unseen. We must be still more spiritually organized to see God and live.

There is a principle of completion in nature, and as it is applied to our life it signifies that we also shall be made perfect. As we follow it out, and, with a confidence in it increasing with our knowledge of its thoroughness as a natural principle, apply it to our life and its fulfilment, we ask in what further ways may we look for our human evolution? how shall unfinished nature in us also be made perfect and entire? We have come to the seeming end of one whole physiological order of development, yet only to a beginning of our inner life of power and love; — it were unnatural, should the process stop, — what shall the end be?

There is one direction which we have thus far only generally considered, in which the higher evolution of man is conceivable, — that is the further advantageous development of his environment. Let us examine this possibility, therefore, more particularly.

Evolutionary writers have repeatedly noticed the striking change which evolution has undergone in the age of man, as the emphasis of it has been transferred from man to his environment. Human development has been very largely a development of environment.

Human history has been a betterment of man's conditions and a vast multiplication of the means of his life. Our environment is not merely a physical one, and its improvement has not consisted simply in better habitations, fitter food, more sanitary conditions, and greater command of the elemental forces of nature. Our human environment is also social, intellectual, moral. We possess in it what is called the increment of tradition. The words which a child now learns are

> "Words that have drawn transcendent meanings up
> From the best passion of all bygone time."

Historic soil is rich. In further improvement of our environment, therefore, we may hope for happier development of humanity. Looking on in this direction, our philanthropists give, our educators toil, our statesmen build, our thinkers lead, and our socialists dream. So when the social environment shall be best fitted to man's individual life, men say the kingdom of heaven will have come on the earth. But even thus will it so come as it is in heaven?

Let us suppose that evolution, which has already neared its end in the physiological life of man, shall have entered upon a happier era in man's social condition; would that be the end of the vista of life's promise? Would that close the book of the prophecy of life's age-long tendency towards completion?

We must here take account of some lines of development which would not be finished, and some human wants of vital essentiality which would be left unsatisfied, even if such social perfection should come at some future age upon the earth.

One of these unfinished lines of life, which on the scientific principle of progressive completion we may hope with a vital trust to see sometime continued unto perfection, is the relation of the spirit within us to its outward element. Eternal life involves in its scientific idea perfect adaptation to perfect environment. The full conception of life's completion can be realized only in the achievement on the one side of real spiritual freedom — a spiritual character made safe forever in its moral integrity; and, on the other hand, in the fitness for it of some environment corresponding fully to its being, as the air answers to the life for its breath, or the light answers to the eye for its vision. This is the scientific idea of perfect life, if life in us is ever to reach forward to perfection. It is the full and final harmony of the spirit which is in man with the revealed presence of God in all the universe without. It is the whole truth of that one deep word of the Master: To know God is eternal life. To be a being who can know, and to be in relation to the divine, which is knowing, — that is full, harmonized life, — the eternal kind of life.

Man's unfinished life in its present spiritual being and knowing is nature's present prophecy of this consummation of it. We have this true life as yet only in its rudiments. We possess our immortality now, but only in its prophetic beginnings. Reflect how far, of all the children of nature, man still is from happy adjustment to his native air and element. He is not yet spiritual master of the universe in which he was born to reign. Its forces mock him; its elements over-master him; a microbe may rob him of his strength; a single cell, living for itself in his bodily tissues, may quickly destroy him. Only a thin crust of one of the least of the heavenly bodies offers him shelter, and he has not yet received the freedom of the skies. His intellect transcends the bounds of his narrow abode, but the stars are more than he can number; and the dust of his own little earth hides from his science its elemental secrets. He must serve the outward powers which he is conscious that he was born to rule. The age of the spirit is not yet come, it is only coming, in the reign of man. Every new art acquired, every scientific lordship which is won over natural forces, every larger generalization of his knowledge, evinces his natural supremacy of spirit, and is prophetic of his rightful sovereignty; nevertheless, man in his present mastery over the visible universe is still only heir apparent, and not yet king enthroned. He stands not yet at the centre, and radiant, the visible universe made subject to him, — even as a Christian prophet saw an angel standing in the sun. Can lordship like that be expected under the limitations of man's immediate embodiment, and in his present imperfect relation to the material creation? Or shall his spirit enter into some freer and happier adjustment to environment more fitted to its nature, in order that its perfection of power may be realized?

There is nothing in our knowledge of nature to preclude the possibility of some more spiritual relation of mind to matter. We may say with the poet-philosopher Herder that embodiment is the end of all God's ways on earth; but we have no scientific reason to deny that this earthly embodiment may itself be but the beginning and prelude of some better embodiment in the heavens. Embodiment, as we know it, may itself be as the seed of a new order, the first stage in a new process of evolution, the open way towards a life which shall be made perfect in its spiritual touch and contact with the outward universe. Because death brings to an end the present and perhaps rudimentary form of embodiment, we are not scientifically or rationally justified in concluding that the process of embodiment for spiritual life has come to an end, or that it is not to be continued in some other and fairer growth and fruition. The final completion would be the self-conscious spirit in perfect touch with the universe; and towards completion the whole creation tends. This is the positive momentum of the argument from nature for our immortality, — towards completion our life also must tend.

The naturalness of this expectation of future life in happier adaptation to material environment, or the open scientific way for the soul's immortal hope, may appear further when we reflect upon an aspect of evolution with which naturalists are often deeply impressed. We refer to the critical points which occur in the processes of nature, at which, without breach of continuity but with very slight modification in physical conditions, a vast change is brought about, and an entirely new series of actions in nature is effected. Evolution is continuous as energy, but it is not uniform in its effects. Crises occur when suddenly new qualities are taken on and great transformations are accomplished.[1] Such critical changes in natural evolution are properly adduced as instances to show the larger possibilities of life than may now appear. A familiar yet ever wonderful example, often cited, is the entire change of conditions and the assumption of new qualities which take place in the history of a drop of water at different degrees of temperature. Nature certainly admits of wondrous transformations, which could not have been previously conceived, and now hardly could be believed, had they not been commonly witnessed. The law of the conservation of energy does not exclude, rather it renders possible for our life also some great transformation. The connection of soul with body, the dependence of the personal being with his inherited individuality upon the molecular matter of his body, is a very slight and easily changed connection; it is no fast and indissoluble bond. In its embryonic beginning it is all contained and conditioned in a mere dot of microscopic matter. The physiological connection of men from generation to generation is a merest thread of protoplasmic substance. It is almost too small for the microscope to render it perceptible. One thing which biology makes plain — and the plainness of it may awaken awe — is this fact that mind does not need for its birth and its coming to its inheritance, a whole body, a complete brain, a fully formed organ of sense, or so much as a single nerve; a few microscopic threads of chromatin matter in the egg are enough. To dimensions so infinitesimal is the dependence of

[1] These points of apparently rapid transformation are happily called by Cope "expression points." *Primary Factors*, etc., p. 25.

personal individuality upon the physical world reduced in its origin. But death, like birth, is a critical point — another crisis in the continuous history of life. The little that we know of birth into the world does not warrant us in saying that death out of it cannot be a new birth into other and larger relations with the universe. And what we do know of the slightness of the connection of personal life with matter at its birth, does justify us scientifically in affirming that the dissolution of a body is not necessarily the destruction of all relation of the individual to the outward universe. The bridge for the open way of the soul, both at birth and death, may be laid from the foundations of the world, although it may not in either case be visible to our senses. Biology has no knowledge from which to bring a negative to life and its transmission either from before birth or after death. It leaves the onward way of the soul clear. Such being the case, the positive argument, which we have just adduced from nature's great, vital principle of completion, finds room and may be allowed free scope in our hope of immortality.

Into the depths of this great truth of nature our own Whittier struck the roots of his fair, sweet faith in the Eternal Goodness, and from it grew the richness of his life's autumnal song:

> "And present gratitude
> Insures the future's good,
> And for the things I see
> I trust the things to be.
>
> "Parcel and part of all,
> I keep the festival,
> Fore-reach the good to be,
> And share the victory.

"I feel the earth move sunward,
I join the great march onward,
And take, by faith, while living,
My freehold of thanksgiving."

To this trust in nature, from which springs sweetest faith, one other great triumphal principle of life adds its clear word of prophetic expectation. We appeal to nature's increasing estimate of individuality in comparison with the species. You will recall the process of individuality which we may trace from far beginnings. Individuality we have seen to be one of nature's ends. The last word of organic development is the individual and his worth. The idea of the perfection of the individual person is involved, therefore, in any scientific conception of the completion of evolution. The perfection of the individual person is an essential part of a fulfilment of life which can be scientifically conceived. For life would not be carried out to completion on one of its main lines, it would stop short and be turned back in one of its progressive and dominant principles, if individuality should be gained only to be lost, if the person should miserably perish, and only the species survive, only the life of humanity continue. The most significant, yet usually overlooked fact that, as evolution proceeds, the interest of the individual in life becomes greater, or as it may with equal truth be put, the interest of life in the individual becomes greater, is of supreme interpretative value, and it throws a flood of light along our future way. In man the individual has become paramount. His personality stands out against the sky as nature's supreme fact. Man, the individual, has acquired survival value. Lower down the individual was sacrificed to the species; on the height the species exists also for the individual. Personal immortality is now and henceforth nature's conceivable best. And nature's best is nature's sure word of the coming life. Add then to trust in the principle of completion this consideration that nature's possible best is the individual possessed of immortal survival value, and the natural argument for the continuation of personal life through better adaptations to the outward universe becomes rounded out and clear. The promise of life from the far past, and in the present unfinished world, nature will keep in the unknown future. Hence in their hunger and thirst for life our human hearts become their own true prophets, and our best human life is its own sure interpreter. We must learn our song from our life. The incompleteness which we so deeply know, the strange brokenness of so much human life and love, the utter unintelligibleness to our thought and feeling of our personal life, if it has no larger sweep, no fuller joy, no heavenly freedom, — all this present partialness of our truest and worthiest achievement is as one grand annunciation, ever growing clearer and fuller, of the life to come, if indeed we have ears to hear nature's one deepest truth in the voice and story of all unfinished life.

The power of nature's continuance in well doing which the whole progressive revelation of evolution declares, shall not fail us in our hour of mortal change. This strong principle shall not prove a broken reed in the grasp of our human hope. The same Power whose word of life has been kept up to man's coming upon this earth, will not at last, and with sudden infidelity, break troth to our human heart. Surely mind has not been called forth to know, in order that after a moment's passing glance it might be tossed back into oblivion. The human heart has not been made simply that it might be broken. The scientific principle of prophecy from the world's hunger has proved thus far to be true to the history of life; and as it is true up to the hunger and thirst of man's spirit for the living God, we have no reason to suppose that it will at last turn false in our most essential life, and immortal need. Hunger, seemingly cruel at first, restless, importunate, eager — hunger, through which life nevertheless has been led far up — hunger, itself transformed and transfigured in man's soul, is crowned at last with a beatitude: Blessed are they that hunger and thirst after righteousness, for they shall be filled. Upon this highest height of evolution and of history we behold our humanity transfigured, ascending, glorified in the Son of man. In him the life was light. Life had come in his knowledge of the Father to its full self-revelation. In Him life and immortality — the final immortality of life — were brought to light: for of Him disciples of old were saying, and of Him, in view of nature's prophecy of the completion of life in the highest, it should be confessed: It was not possible that he should be holden of death: Thou wilt not give thy Holy One to see corruption.[1]

There is another prominent aspect of this principle of completion, which has hardly been noticed in the whole literature of the subject, but which is clearly and strik-

[1] Acts ii. 24; xiii. 35.

ingly presented in nature's own evolutionary argument for man's immortality. It is this: the will to live is a supreme achievement of evolution; and the energy of man's will to live is to be taken into the account as a factor of his future evolution. The will to live is a product of evolution; but when once it has been clearly and consciously gained in man's life, it enters as a distinct factor into the course of evolution, and henceforth its possible working and results are to be considered in any scientific forecast of futurity. We may trace the will to live from the first stirrings of animal existence. It is a primal motion, an original impulse, a natural instinct of life. It grows and gathers strength, until in the higher animals it becomes dominant, and renders subservient to itself the developed powers of muscle and sense, of attack and flight, of instinct and intelligence. In man this will to live becomes a clear, spiritual flame, and in it everything foreign to it is consumed, until it too seems quenched forever. But can a flame so spiritual be quenched?

It should be noted that the will to live not only resists hostile and destructive forces, but also it shows signs of constructive and adaptive power, by which it fashions new conditions to its use, and makes for itself more fitting environment. Man's strong will to live evinces its self-maintaining energy by marked reactions upon the physiological environment; the physician is aided by it; disease is held in abeyance by it; it seems at times to have power to put off death. Moreover, it manifests its higher spiritual energy as power to suffer and to strive, to think and study, to achieve and to love, without heed of time or fear of death. This deathless will to live is a force among the nature-forces, which may have more meaning for our future life than has been dreamed of in our philosophy. It often shines forth most brightly, and is most triumphal, in the very hour of death. If the strong immortal will to live of a thoughtful, noble man be not merely a self-assertive force, but also a creative energy of life, having power to adapt to itself other conditions and elements of being, although it must let this mortal body go; then clearly immortality may be a possible achievement of the spirit which is in man, as well as the gift of God. If the adaptive and constructive will to live is in man the last and highest result of evolution so far, then its continuance and self-maintenance, in other and perhaps better conditions, would not be a thing incredible; it would be rather the natural completion of the will to live, which we should scientifically expect to see fulfilled, as we expect any other energy in evolution to be used to its utmost.

The will to live, in which the fear of death is overcome, has shown its most forceful virtue in the supreme souls of human history. It was declared in Socrates' defiance of death; — you may kill Socrates, if you can catch Socrates. It has shone in the triumph of the martyrs; it has sounded in the jubilance of the heroes; it has lighted the faces of the saints. These go not down to death in passive resignation merely: they go up through death in active exercise of spiritual faith to greet the promise; in dying they make death subject to them. In the consciousness of man at its highest power, even in the mind that was in Jesus, the spiritual will of life was constant, abounding, unconquerable. The Son of man would say to his friends, as one of us might say of any earthly purpose, naturally, and without shadow of doubt: I live; — For as the Father hath life in himself, even so gave he to the Son to have life in himself: — I go to the Father: — I come again: — but now I come to thee: — I ascend unto my Father and your Father, unto my God and your God. Thus the will to live as the Son of God, a will in itself invincible and divine, overcomes death, and cannot be held in corruption.[1]

There is one feature of the natural ascent of life to personality, and its prophecy of completed life, which all along has been implied in the argument from unfinished nature, which we should not leave without a word of explicit declaration. We have observed that the process of individualization in nature, which ends in distinct personality, does not leave the individual in separation from the world; it is rather the perfect adaptation of life in self-consciousness to the universe without. Personality is not, we have remarked, fully conceived as a thing by itself; it exists in its relations to all around it. It rises indeed above nature, but never out of the great whole of the creation in which it has share and part. It is life in conscious oneness with the universe, — life at home in all the worlds. It is life possessing happy sense of its belonging to all around it, even as the son, and not as the servant, in the

[1] For further consideration of this argument for immortality from the immortal will to live, see the author's *Personal Creeds*, Chap. vi.

Father's house. Personality is itself more than a single isolated point of sensitiveness; it is a social achievement and an entering into possession of all life; it can look abroad and up to the stars, and in its glad Christian self-consciousness sing to itself, — All things are yours; whether human friends, or the world, or life, or death, or things present, or things to come; all are yours; and ye are Christ's; and Christ is God's.[1]

The prophecy of immortality, therefore, so far as we may read it from the evolution of individuality, is a promise likewise of social immortality. The eternal kind of life, even now as we enter anticipatively into its worth and joy, is communion of spirit. We pass into it and have it, as we share it with others, — the living and the dead. Only in communion with the universal life is our individuality to be made full. We lose our self-life that we may gain it in fellowship with the Father and with the Son. The life, which is life indeed, is fellowship with the human and the divine. Fellowship is life's last, greatest, and immortal word.

The same principle of completion, therefore, which raises the scientific presumption of the future continuance of the individual life, justifies further the Christian faith that it shall be a life likewise of perfected touch and contact with the outward creation, and of supreme satisfaction in the comradeships of kindred spirits. Personal immortality, in a word, involves in its completion social immortality. He in whom the life came to full revelation as the light of the world, describes its completion after a little while, not in material imagery,

[1] 1 Cor. iii. 22.

or outward splendors, but in simple words of intimate personal relations and friendships: Ye shall see me again: I, thou, we, — all made perfect in one. Such is the possible social completion of man's life in the glory which the Son had from the beginning with the Father, and which he prayed that the disciples might share with the Son, that all might be one.

To follow this hope of social immortality in further Christian assurance of it, would lead us beyond the limits of the argument for eternal life from nature's present achievement and prophecy. But while natural theology can only lead us to the threshold, it leaves us before an open door, waiting for supernal revelation. We are not yet born into this larger world, but nature has formed and nourished us for its liberty. Man's life, still cherished in nature's womb, feels the stirrings within it of unknown powers, and has present embryonic consciousness of its immortal worth. First is that which is natural; and afterwards — its sure fulfilment — is that which is spiritual. What things are prepared for us in some large, sunny realm, into which we shall be born again through death, and how in some fair harmony with nature our spiritual life shall be made perfect, — these things the heart of man cannot conceive: this is the Christian hope of the glorification of life in the resurrection. We know not what it shall be: but we know that it shall fulfil the law and the prophets of nature, while it shall transcend them all.

There is a wonderful passage in a letter to the Romans of the chief of the apostles, in which there occurs an expression which could not have sprung from any of the literatures or philosophies of his age, but which witnesses to the new Christian conception of the creation in its spiritual unity and hope. We may bring fresh meanings to it from our modern sciences, and use it as the summation, in a word, of the highest interpretation of nature which we may learn from our scientific studies of its origins, its struggle for existence, its increasing vital values, its entrance of death for the sake of life, its preparation of the way for the coming of the person and the glory of the Son of man, and from its unfinished life in its sure word of prophecy: with richer knowledge of evolution than Saint Paul could have dreamed to fill the words with luminous meanings, at the summit of the century's science we may lift up our hearts and confess: *For the earnest expectation of the creation waiteth for the revealing of the sons of God. For the creation was subjected to vanity, not of its own will, but by reason of him who subjected it, in hope that the creation itself also shall be delivered from the bondage of corruption into the liberty of the glory of the children of God.*

INDEX

INDEX

Acquired characters, 205.
Æsthetic sense, evolution of, 154.
Agnostics, 52.
Alcoholism, immunity from, 217.
Algæ, 139.
Amœba, 21, 42, 62, 248.
Andrews, Mrs. E. A., 72.
Aristotle, 230.
Ascaris, 32, 36, 69.
Asclepiadæ, 141.
Atoms, dance of, 56.
Augustine, St., 101.

Bateson, W., 243.
Beauty, criticism of utilitarian theory of, 138.
  Darwinian account of, 133.
  existence of, when not useful, 141.
  for reason, 154, 158.
  interpretation of, 154.
  moral, 158.
  moral aspect of natural, 157.
  utilitarian theory of, 137.
Biology, the higher, 8, 84.
  province of, 5.
  uncertainties of, 7.
Birds, colors of, 135.
Brooks, W. K., 101, 171, 230, 239.
Browning, Robert, 240.
Bunge, G., 167.
Butler, Bishop, 1.
Bütschli, O., 163, 232.
Buxton, Sir Thomas Fowell, 62.

Cell, contents of, 27, 31.
  co-ordination of, 71.
  discovery of, 13.
  division of, 33.
  germ and somatic, 36.
  individuation of, 165.
  nutrition of, 165.
  relative time in differentiations of, 74.
  structure of, 60.
Chalmers, Thomas, 8.
Chance, theory of, 54.
Chemical Physiology, 166.
Child, C. M., 73, 74, 75.
Christian Science, 106, 209.
Chromosomes, nature of, 33.
  number of, 69.
Clavelina, 89.
Color, autumnal, 140.
  elemental in nature, 148.
  in lower organisms, 139.
  organic, photographic sensitiveness to, 148.
  protective, 134.
  use of, in flowers, 137.
Completion, evidence of principle of, 231.
  in man's life, 258.
  prophetic value of the principle of, 254.
Conn, H. W., 243.
Conservation of energy, law of, 13, 263.
Conservatism, of the germ, 205.
  of organisms, 207.
Cope, E. D., 207, 244, 263.
Courtship, natural history of, 135.
Critical points, in evolution, 262.
Crystal, appearance of, in evolution, 163.
  compared with cell, 19, 163.

Cytology, 7, 28.
Cymonomus, 197.

Dante, 25, 53.
Darwin, Charles, 2, 32, 79, 80, 134, 135, 136, 137, 138, 145, 241, 243, 245.
Darwin, F., 15.
Death, critical point in life, 264.
 for the sake of life, 199.
 relation to the fall, 199, 201.
 spirit, active in, 269.
Descent of man, 2.
Degeneracy, see retrogression.
Development, embryological, 33.
 in inorganic world, 236.
Direction, embryological, 68.
 character of, 95.
 fact of, to be known, 50.
 in the inorganic world, 53.
 in the organic world, 59.
 in history, 129.
 intelligent character of, 108.
 moral in nature, 116.
 summary of facts concerning, 91.
Driesch, H., 231.
Drummond, Henry, 23, 24, 225.

Echinoderm, 72.
Edwards, Jonathan, 185.
Eimer, T., 149.
Elements, evolution of, 161.
Embryology, 68.
 recapitulation in, 40.
Energy, conservation of, 13, 263.
 law of release of spiritual, 220.
Environment, development of, 258.
 further adaptations of to man's life, 255.
Eryonicus, 197.
Eternal life, 260.
Ether, the, 55.
Evil, problem of, 129, 217.
Euglena, 14, 43.
Evolution, arrest of in man's body, 181.
 by atrophy, 197.
 change of order in, 57.
 factors of, 83.
 further possibility of for man, 256.
 geological progression of, 56.
 intelligible as spiritual, 178.
 method of, 84.
 of man's environment, 258.
 of scientific instruments, 257.
 theories of, 79.
 unknown factor of, 111.
 use of the word, 4.
Ewart, J. C., 83.
Eye, evolution of, 41.
 increasing revelation to, 45.
 loss of, 197.

Fall, evolutionary doctrine of the, 201.
Fertilization, of flowers, methods of, 144.
Fischel, A., 210.
Fiske, John, 188.
Fitness, significance of, 102.
Foraminifera, 138.
Form, development of for intelligence, 238.
 precedes variation, 91.
 progress of, 235.
 relation of to function, 235.
Francis, Saint, 16.
Fry, Mr. Justice, 143.
Function, development of, 235.

Galton, F., 195.
Goal, in nature, 247.
Goethe, 49.
Gray, Asa, 14, 147.
Groos, K., 124.

Haeckel, E., 11.
Happiness, man's compared with animal, 119.
Herder, J. G. von, 261.
Hertwig, O., 66, 83, 85, 112, 209, 231, 232.

Higher criticism, of science, 8.
Hunger, predictive value of, 267.
Hydra, 66, 102, 208.

Immortality, naturalness of, 262, 266.
personal, 265.
social, 270.
Individual, first step towards, 161.
increase of value of, 187.
perfection of, 265.
survival value of, 190, 266.
tendency towards, 160.
worth of, as an end in itself, 183, 189.
Infancy, prolongation of, 188.
Infusoria, 63, 87, 117, 126.
Insects, eyes of, 145.
sense of color, 145.
Intelligence, increasing release of, 220.
animal, 168.
directive action of, how conceivable, 110, 115.
evolution of, 21.
evidence of, in natural direction, 108.
human related to animal, 22.
Instinct, animal compared with human, 183.

Jennings, H. S., 88.
Jones, E. G., 199.
Joylessness, of lower organic world, 126.

Kant, 157.
Kassowitz, M., 142.
Kepler, 67.

Labor, division of, 62.
Lamarck, 82.
Laplace, 250.
Laws, not identical, 23.
Le Conte J., 57.
Lens, reproduction of, 210.
Life, a new order, 57.
communal in nature, 64.
connection with inorganic, 16.
dark side of, 120.
duration of, 188.
educable matter of, 18.
mechanism of, 76.
origin of, 17.
physico-chemical theories of, 77.
waste of, pre-natal, 122.
Lillie, F. R., 76.
Limitation, law of, 127.
sign of, 105.
Lockyer, N., 56, 102.

Man, condition of further ascent of, 256.
end of physiological evolution in, 256.
oneness of with nature, 173.
organic approach to, 240.
unfinished life of, 255, 260.
Marshall, Milnes, 40.
Materialism, 75, 175.
Matter, origin of, 55.
Maxwell, J. Clerk, 96, 99, 113, 114, 115.
Mechanism, in biology, 85.
insufficiency of, 87.
of cell-division, 214.
Metabolism, 165.
Metazoa, 64.
Method, of this discussion, 5.
Mikrogromia socialis, 63.
Mind, advent of in nature, 172.
directive energy in matter, 109, 239.
possible relation to matter, 261.
Mohr, K. F., 13.
Morgan, Lloyd, 21, 83, 221, 229, 234.
Morgan, T. H., 210, 229.
Morris, J., 98, 176.
Mozley, Canon, 157.
Mutations-theory, 243.
Myxomycetes, 63.

Nägeli, 228, 230.
Natural and spiritual, relation between, 10.
  law in the spiritual world, 23.
Natural selection, 80, 241.
  in man's development, 246.
  not first in nature, 90.
  insufficiency of, 80, 84, 138, 241.
  verification of, 242.
Natural theology, the old and the new, 3.
Nautilus, 44.
Němec, B., 15.
Nemertea, 140.
Neo-Darwinians, 206.
Neo-Lamarckians, 82, 206.
Newbigin, M. I., 148, 149.
Newcomb, S., 111.

Order, enumeration of kinds of, 97.
Orderliness, sign of, 95, 98.
Organization, primal fact of, 61.
Organism, standpoint of, 73.
Osborn, H. F., 79.

Paley, 4.
Pantheism, 175.
Parasitism, 198.
Parker, T. J., 14, 103.
Pascal, 133.
Pearson, K., 86.
Perfection, principle of, 228.
Personality, acquisition of, 170.
  conception of, 175.
  meaning of advent of, 179.
  specialization of spiritual energy, 171.
  theories of origin of, 171.
Physiology, chemical, 77.
Plants, resemblances to animals, 15.
  sensation in, 15.
Plateau, F., 146.
Play, origin of, 123.
  perversion of, 125.
  utility of, 124.
Pleasure, growth of vital capacity of, 118.
  increase over pain, 120.
Principles, of nature, continuity of, 24, 158.
  importance of, 6.
Progress, of evolution, theories of, 241.
  signs of, in history, 130.
Prophecy, natural principle of, 250, 253.
Protamœba, 168.
Protococcus, 168.
Protoplasm, continuity of, 72.
  structure of, 29.
Protozoa, 64, 205.
Providence, in the least and the greatest, 59.
  in timing events, 73.
  in development of cells, 68.

Quality, throughout nature, 109.

Radiolarian, 224.
Reason, unifying principles of, 24.
Redemption, natural law of on higher plane, 219.
  Christian doctrine of, 219.
Reformative power, 212.
Regeneration, diminution of power of, 209, 215.
  in personal life, 216.
  mechanics of natural, 214.
  moral continuance of, 218.
  of lost parts, 208.
  physiological, 217.
Reid, C. A., 216.
Responsibility, entrance of moral, 200.
Retrogression, fact of, in evolution, 193.
  Galton's law of, 195.
  involved in variation, 194.
  provided for in progress of evolution, 202.

Revelation, in the cell, 27.
in human history, 47.
method of, 26, 38, 39, 41.
natural principles of, 46.
Romanes, G. J., 102, 129, 177.
Roux, W., 211.
Ruskin, John, 153.

SACRIFICE, and service, relation of, 224.
diminishing necessity of, 224.
Sandeman, G., 139.
Schleiden, 13.
Schwann, 13.
Science, epochs in relation of to Faith, 2.
modesty of true, 8.
prophetic principle of, 251.
Selection, sexual, 135.
Sensitiveness, growth of, 117.
of living matter to light, 42.
Sentiency, animal, 168.
increase of, 169.
Service, law of increase of, 224.
Sex, disappearance of, 191.
first traces of, 65.
Shaler, N. S., 18, 139, 147, 165, 237.
Simroth, H., 148.
Sin, possible in evolution, 201.
remoter good from history of, 204.
Siphonophores, 66.
Slime-moulds, development of, 75.
Smyth, N., 27, 191, 270.
Son of man, reveals power of life, 267.
his will to live unconquerable, 270.
Soul, connection with body at birth and death, 263.
Species, death of, 191.
preservation of, 184.
Spencer, Herbert, 5, 123, 167.
Spirit, coming age of, 261.
priority of, 177.
Spirogyra, 150, 167.
Stimulation, organic response to, 87.
Strassen, O. L. zur, 76.
Substitution, in nature, 211.
in theology, 223.
Sufferings, of animals, 121.
Symbiosis, 224.

THEOLOGY, natural, need of new, 3, 9.
Thomson, J. A., 79, 124, 212.
Titon, 210.
Trembley, Abbé, 208.
Truth, love of, 1.
Tyler, J. M., 240.
Tyndall, J., 153.

UGLINESS, reason for, 151.
tendency to remove, 152.
Unity, genetic, 12, 22, 80.
of vegetable and animal kingdoms, 14.
of creation, 11.
spiritual, 23, 180, 273.

VAMPYRELLA *Spirogyræ*, selection of matter by, 167.
Variations, cause of, 243.
transmission of, 81.
Varieties, useful in man's conditions, 254.
Verworn, M., 18, 115, 166, 167, 247, 248.
Vicariousness, naturalness of, 223.
in Christian redemption, 223.
Vital value, characteristics of, 104.
increase of, in history, 129.
law of increase of, 103.
Vorticellidæ, 138.

WALLACE, A. R., 121, 122, 136, 140, 144, 145, 151, 245, 256.
Walton, Izaak, 129.
Ward, J., 50, 111, 177, 236, 249.
Wealth, increase of moral use of, 130.

Weismann, 81, 82, 187.
Whittier, J. G., 264.
Will, limit of the, 221.
    the will to live, 268.
Wilson, E. B., 16, 19, 71, 72, 76, 88, 89.
Wolff, C. F., 1.
Wolff, G., 210.
Wordsworth, William, 46.

Yucca moth, the, 184, 233.

Zooids, 65.
Zoothamnium arbuscula, 64.